BOW INSTRUMENTS

THEIR FORM AND CONSTRUCTION

by

J. W. GILTAY

LONDON
WILLIAM REEVES

Date Due

SU 7 22 77		10/19/94	

BOW INSTRUMENTS
THEIR FORM AND CONSTRUCTION

BOW INSTRUMENTS
THEIR FORM & CONSTRUCTION

PRACTICAL AND DETAILED INVESTIGATIONS AND EXPERIMENTS REGARDING VIBRATION, SOUND RESULTS & CONSTRUCTION, INCLUDING THE EXAMINATION OF THE VIEWS OF AUTHORS IN VARIOUS LANGUAGES ON THE PHYSICAL AND MECHANICAL SIDE OF THE INSTRUMENTS

ALL EXTRACTS FROM FOREIGN AUTHORS APPEAR IN ENGLISH AS WELL AS IN THE ORIGINAL

BY

J. W. GILTAY

ISSUED INTO ENGLISH BY THE AUTHOR IN CO-OPERATION WITH E. VAN DER STRAETEN

LONDON

WILLIAM REEVES

Made in England
by Lowe & Brydone (Printers) Ltd., London
for William Reeves Bookseller Ltd.,
1a Norbury Crescent, London, S.W.16

PREFACE.

IN the following pages I have tried to describe as simply as possible the function of the different parts of bow instruments.

Most books dealing with this subject begin with an elementary treatise on acoustics; I have omitted this, and supposed the reader to be sufficiently acquainted with that science. If he is not, he can easily obtain this knowledge from some text-book.

Some readers may possibly think that too many pages have been given up to refuting what I regard as erroneous views on various points; but the course taken seemed to be essential because so many wrong notions still appear in the literature on this subject, the authors apparently copying them one from another. The English version of the work has been brought right up to date, and consequently, on several points, contains matter over and above what is given in the Dutch version.

I have much pleasure in thanking Professors Dr. M. de Haas, of Delft, and Dr. H. Haga, of Groningen, for several valuable remarks and hints.

Mr. E. van der Straeten kindly revised the translation before it was placed in the printer's hands.

DELFT. J. W. G.

CONTENTS.

Chapter III.—THE BELLY OF THE VIOLIN.

Chapter IV.—THE SOUND-POST.

Chapter V.—THE BACK.

Chapter VI.—THE INFLUENCE OF THE ENCLOSED AIR.

Chapter VII.—THE F-HOLES.

Chapter VIII.—THE BASS-BAR.

Chapter IX.—THE INFLUENCE OF AGE ON THE VIOLIN.

Chapter X.—THE MUTE.

INTRODUCTION.

UNTIL now few physicists have taken notice of bow instruments.

Undoubtedly the foremost worker in this line has been Felix Savart, who has made a great many very simple and very original experiments on the subject of acoustics and their application to bow instruments. Helmholtz has made an elaborate study of the motion of a bowed string; after him Neumann* and Krigar-Menzel-Raps† have worked on the same lines. Huggins has studied the motion of the belly of the violin, and Barton that of the belly, the bridge and the strings.

But for the rest, very few physicists have approached the subject, the reason probably being that a scientist not playing a bow instrument generally takes little interest in it.

In many books treating of bow instruments and their manufacture, some physical notions are given about the function of the different parts of those instruments, but they are mostly of little value, if not quite valueless.

In this book I intend to deal one by one with the principal parts of the violin and their functions. As all bow

---

* Wien. Ber. II, 1870, p. 89.

† Wied. Ann. Bd. 44, 1891, p. 623.

instruments (violin, viola, violoncello and double bass*), though of different size, are made on the same pattern, I will confine myself chiefly to the violin.†

Fig. 1 shows the different parts of the violin.

The four strings from left to right are tuned G′, D′, A′ E″. The G string, sometimes also the D, is a sheepsgut string covered with silver wire or silvered copper wire, the

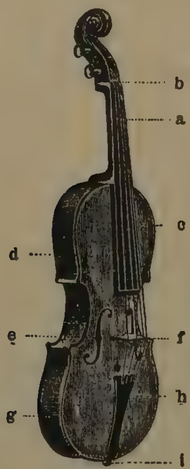


Fig. 1.

* The double-bass was sometimes made so large that a boy could be concealed in it. Mersenne ("Harmonie Universelle," 1627, p. 192) tells the following: "On les fait de toutes sortes de grandeurs, dans lesquelles l'on peut enfermer de ieunes Pages pour chanter le Dessus de plusieurs airs ravissans, tandis que celui qui touche la Basse chante la Taille, afin de faire un concert à trois parties, comme faisoit Granier devant la Reine Marguerite." Sir Walter Scott tells a somewhat similar story, of a dwarf being concealed in a violoncello, at the Court of Charles II. ("Peveril of the Peak," Chapter XLVI.)

† A new kind of bow instrument, named baritone-violin, has recently been put on the market by Gustav Walch, Radebeul-Dresden 3. Its dimensions are the same as those of the viola: it is tuned an octave lower than the violin.

remaining two strings being of sheepsgut only. For the E string steel wire or silk is sometimes used.*

a is the fingerboard, on which the strings are pressed down, or stopped, by the player's fingers.

b the saddle, a small elevation of the fingerboard, on which the vibrating part of the string ends.

c the belly or table.

d the back.

e one of the f holes.

f the bridge, being a small flat piece of wood standing between the belly and the strings, and kept in position by the pressure of the strings.

g the rib, connecting the belly with the back.

h the tailpiece.

i the button, to which the tailpiece is fastened by a piece of catgut.

The bridge is better seen in Fig. 4. What is at the left of Fig. 1 I shall hereafter call the left side of the violin. Thus, when speaking of the left foot of the bridge, the foot next to the G string is meant.

Between the belly and the back is placed the soundpost or sound bar, a cylindrical piece of wood. This is not shown in Fig. 1. It is placed somewhat behind the right foot of the bridge, as shown in Figs. 48, 49 and 50. (In Figs. 48 and 49 the soundpost is not shown at full length, but only in part.)

Inside the belly, under the left foot of the bridge, a strip of wood, called the bass bar, is to be found. It is not visible in Fig. 1, but is shown in Fig. 48 in its proper place. Fig. 56 shows the inside of the belly, so that the bass bar appears on the right side, while Fig. 57 shows it in profile.

When a violin string is sounded, this is what happens: the string is put into motion by the bow, and this causes

* The E string is sometimes called the quint, dating from the time when five strings were used, as was the case, for example, with the "Pardessus de Viole."

the bridge to vibrate and in its turn communicate its motion to the belly. The belly transmits its vibrations to the air outside the instrument as well as inside; while the back is set into vibration by the inner air as well as by the soundpost and the ribs.

Owing to the smallness of its surface, a single string is unable to produce a sufficiently strong vibration of the surrounding air; in the case of the violin it is made to vibrate two wooden boards (the belly and the back), whose large surfaces are capable of communicating an ample amount of vibratory motion to the surrounding air.

Apian-Bennewitz* says that the vibration of the surrounding air caused by the belly is stronger than that caused by a string alone, because the resistance offered by the air to the belly is stronger than that offered to the string. This is obviously wrong: in proportion as the air-resistance was smaller, the air would be brought into still stronger vibrations by the belly.†

---

* Apian-Bennewitz, "Die Geige, der Geigenbau und die Bogenverfertigung," 1892, p. 125.

† A striking experiment showing the influence of a large co-vibrating surface communicating its vibration to the air is the following: a musical box is enclosed in a case, padded with several layers of felt. A small wooden stick, resting upon the musical box, projects. When the box is playing, the music is inaudible, or nearly so, but as soon as a thin disc of wood or a violin is laid on the rod, the music will be heard through a large room. (Tyndall "On Sound," Third Edition, 1875, p. 86.) See also pp. 85-6 *ibid.* where the same is proved for a vibrating string.

A remarkable instance of vibrations being communicated from one body to another, although not having a direct connection with acoustics, is shown by Bréguet's "montre double" ("Ann. de Chim. et de Phys.," T. 12, 1819, p. 239). Bréguet placed two chronometers in the same case and found that they kept exactly the same time. A three months' experiment at the Observatory showed them to give precisely the same indications at the end of that period.

A similar observation was made by Huygens, as early as 1665, with two pendulum clocks, placed at a distance of a few feet from one another (D. J. Korteweg, Kon. Akademie van Wetenschappen, Amsterdam, XIV, October 28, 1905, p. 413).

CHAPTER I.

THE STRINGS.

Equal Tension.

SEVERAL writers are of opinion that the tension of the strings, or their pressure on the bridge, should have the same value for each string.

To arrive at this, the weight of each string should be $\frac{9}{4}$ times as great as that of the next sharper pitched one. As the D, A and E strings generally are made from the same materials, it can also be said that their diameters should stand as 3 : 2. To find the weight of the corresponding G string, that of the D should be multiplied by $\frac{9}{4}$.

Hepworth* gives the following diameters for a set of strings of equal tension:

G	D′	A′	E″
1	1.25	.75	.5 mm.

Huggins† gives:

D′	A′	E″
1.35	.9	.6 mm.

and for the weight of the G 2.2 gr.

---

* "Information for Players, Owners, Dealers and Makers of Bow Instruments, also for String Manufacturers," p. 54.

† Proc. Roy. Soc., XXXV, 1883, p. 247.

B

He found the following values for a set of strings of Ruffini:

D′	A′	E″
1.17	.9	.67 mm.

and for the G string 1.41 gr.

The last-named figures differ materially from the theoretical values: the E string is thicker, the D thinner and the weight of the G much smaller than the theory prescribes. Huggins says with respect to this: "A violin strung with strings of a theoretical size was very unsatisfactory in tone." He does not say whether this instrument sounded better with a set of strings selected by the ear. This probably was so, otherwise the experiment does not prove much.

The reason for taking the E string thicker and the G thinner in practice than required by theory, Huggins seeks in the fact of the bridge being somewhat higher near the G string than at the other side. The pressure on the bridge, caused by the G, would thus be greater than that caused by the E, if both strings were of equal tension. To prevent this, he says, the G is taken a little thinner than the theory of equal tension requires.

As a second reason he mentions that the distance between the G string and the fingerboard is somewhat greater than that between the E string and that board, owing to the greater height of the bridge at the left side. This would compel the player to use more force in stopping the G than when playing on the other strings. To prevent this also, he says, the G is taken a little thinner than required by theory.

Angle between the Two Ends of the String on both Sides of the Bridge.

Delezenne* also maintains that the four strings should be of equal tension. The pressure on the bridge, he says,

* "Expériences et Observations sur les Cordes des Instruments à Archet." Lille, L. Danel, 1853.

should have the same value for each string, in order that the resulting force of the total pressure may pass through the middle of the violin ("Le Plan de Symétrie"). If the tension of the four strings is the same for each, then the pressure on the bridge has also the same value for each string, he adds, as with a well-made instrument, the saddle as well as the bridge is somewhat higher at the left side than at the right, thereby causing the angle made by the two ends of the string, before and behind the bridge, to be equal for all four.

If this is really the case, then the first reason given by Huggins for the difference between the theoretical and the practical size of the G string is wrong.

To convince myself how near Delezenne's requisite of this equality of the angles is approached in practice, I have measured the angles for the two outside strings of four violins and one viola, all of them good instruments, with these results:

	G	E″
Violin No. 1.	156°	157°15
" " 2.	156°	156°15
" " 3.	157°45	156°30
" " 4.	157°15	155°30

and for the viola:

C	A′
158°15	154°30

It will be seen that for Nos. 1 and 2 the angle for the E string is somewhat larger than for the G, while Nos. 3 and 4 show the reverse, and for the viola the angle of the A string is considerably smaller than that of the C.

Judging from these five instruments, it would seem that this equality of the angles is not very accurately followed in practice.

Asymmetrical Inner Construction of the Violin.

It seems to me there is no reason at all for equal tension of the strings. If the violin were a symmetrical body as, for instance, Savart's trapezoidal violin,* there might be something in it, though even then it would not be impossible for the violin to give the higher tones too loud, so that it would require thicker A and E strings than the equal tension theory demands. But with so asymmetrical a body as the common violin, the belly of which is supported at the right side by the soundpost and strengthened at the left by the bass-bar, I fail to see the necessity of equal tension of the strings, and it is obvious that practice alone can say what size of strings a violin requires. As Wettengel† rightly remarks, a general rule cannot be given for the size of the strings; they should be chosen for each instrument separately.

Delezenne says that equal tension would be quite justified with a symmetrical violin, and then tries to show that a common violin may be considered as a symmetrical body: "Si la table était sans barre et l'instrument sans âme, le principe serait incontestable. Par leur position cette âme et cette barre ne me paraissent pas défavorables au principe, du moins je ne vois pas en quoi elles lui seraient contraires." He evidently means to say that the belly may approximately be considered as a symmetrical body as the bass-bar at the left side answers about the same purpose as the soundpost at the other side. This seems to me to be more than dubious: the soundpost acts only on one part of the belly, and prevents there to a great extent its vibrations, whereas the bass-bar propagates

---

* "Mémoire sur la Construction des Instruments à Cordes et à Archet." A reprint of this paper is to be found in "Nouveau Manuel Complet du Luthier," by Maugin and Maigne, Paris, Librairie Encyclopédique de Roret, 1894. See also my Fig. 28.

† Lehrbuch der Geigen-und Bogenmacherkunst. 2e Aufl., bearbeitet von Heinrich Gretschel. Weimar, 1869, Bernhard Friedrich Voigt.

the vibrations over a large surface of the belly. So it can hardly be admitted that both halves of the belly, the right and the left, are behaving in the same way.

Size of the Strings in Practice.

The selection of a string is closely connected with the fact that a thick string may not so easily be divided into small sections, vibrating in opposite directions, as a thin string of the same length. It follows from this that a thin string will give more overtones than a thick one tuned to the same pitch, so that the sound produced by the first is more acute and piercing. A striking example of this is given by the strings of a cither, the sound of which is very thin.*

In order to get a full and strong sound, one selects for any instrument preferably strings as thick as it can bear, but of such a diameter that they are still easily put into vibration.

According to Schroeder,† the customary diameters for violin-strings are:

G	D′	A′	E″	
1	1.25	.9	.7	mm.

Weichold‡ gives:

G	D′	A′	E″	
.85—.975	1.05—1.2	.775—.95	.6—.75	mm.

It will be seen from this that the size of the higher strings in proportion to that of the lower is generally taken somewhat larger than is required by the theory of equal tension, from which it follows that the tension of the higher strings is somewhat greater than that of the lower ones.

---

* "Klimpernd" in German. Helmholtz, "Tonempfindungen," 3e Aufl., p. 135-6.

† H. Schröder, "Die Kunst des Violinspiels," 1887, p. 64.

‡ Apian-Bennewitz, l. c. p. 125.

Tension of the Violin Strings in Grammes.

If the weight of a string, its time of vibration and its length are known, the tension is given by the formula:

$$t = \sqrt{\frac{pl}{981.2\ s}} \text{ or } s = \frac{pl}{981.2t^2},$$

where l is the length in cm. of the string between bridge and saddle, p the weight in grammes of that part of the string, and t the period required for half a vibration, expressed in seconds.

If we use the diameters given by Schröder, we find:

	G	D′	A′	E″	
	1	1.25	.9	.70	mm.
Weight (p)	1	.45	.23	.14	gr.
Period of half vibration (t)	$\frac{1}{390}$	$\frac{1}{594}$	$\frac{1}{880}$	$\frac{1}{1320}$	sec.
Length (l)	320	320	320	320	mm.

If we place these values into our formula, we get the following tensions:

G	D′	A′	E″
5194	5295	5899	8079 gr.

Pressure of the Strings on the Bridge.

Suppose s to be the tension of a string and α the angle between the two pieces of string before and behind the bridge. Further, suppose the bridge to stand perpendicularly on the belly, and the angles between the two parts of the string and the bridge to have the same value. Then, if the perpendicular pressure of the string on the belly be called D, we have:

$$D = 2\ s \cos. \tfrac{1}{2}\ \alpha.$$

For the total tension of the four strings we found 24.431 gr. If we take for α 156°, then D = 10.164 gr.

According to Savart,* the tension of the E string is 20-22 livres,† that of the A about 20 livres, and for the remaining two strings somewhat less. For the total tension of the four strings together he gives 80 livres, or about 40 kgr.

The pressure exerted by the E string on the belly has been determined experimentally by Savart as follows‡: a violin was strung only with an E string tuned to E″; the angle between the two ends of the string on both sides of the bridge was found to be 155°. That spot of the string in which it touched the bridge was marked; then the bridge was removed, care being taken that the peg was not displaced in its hole.

The instrument was then clasped in a horizontal position in a stand, the belly downwards, and the string weighted in the marked spot till the angle between the two ends of the string was again 155°, or, what comes to the same thing, till the string again emitted the tone E.″

Savart found a weight of 6 livres 2 onces, or about 3072 gr., to be required for this.

This cannot be denied as being a very ingenious experiment, but something seems to have gone wrong with it. If in our formula $D = 2\ s \cos. \frac{1}{2} \alpha$ we take for s the medium of 20 to 22 livres, say 21 livres or 10,500 gr., and for α 155°, we find for D the value of 4.536 gr., showing a rather large deviation from Savart's number.

---

* "L'Institut, Journal Général des Sociétés et Travaux Scientifiques de la France et de l'Etranger," 1e Section, 8e Année, 1840, p. 92.

† 1 livre = .5 kgr. = 16 onces.

‡ Savart's description of this experiment is so very short that I found it necessary to give it somewhat more fully. If perchance he did not make the experiment exactly as I describe it, in any case it might be so made.

Motion of the Strings.

Helmholtz has shown by means of his vibration microscope that the motion of a bowed string may be illustrated by a simple zig-zag line. When the bow bites well and the prime tone is powerfully produced, each point of the string has an ascent motion of uniform speed, followed immediately by a descent, also of uniform speed. Fig. 2 shows the motion of a point in the middle of the string, the ordinates giving the displacements, and the abscissæ the values of the time; A B = B C.

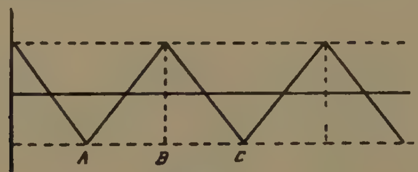


FIG. 2.

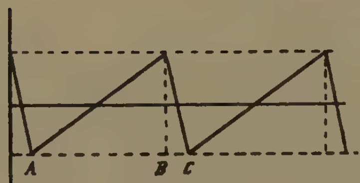


FIG. 3.

For a point nearer to the end of the string, the ratio between A B and B C is the same as that between the length of the two ends of string both sides of the point considered, as shown by Fig. 3. For a point in the middle of the string, Fig. 2, both motions have the same velocity.

During the greater part of each vibration the string clings to and moves with the same velocity as the bow. Owing to the increased tension of the string, it finally leaves the bow and springs back; this motion, as we have

seen, is also of uniform speed, caused by the friction of the resined hairs of the bow.*

Sometimes, however, the string, during its descent motion, sticks to the bow, and is again carried along during a very short period, after which it springs back to continue the descent motion. In that case the zig-zag line is alternated and shows little wrinkles or curls.

Connection between Velocity of Bowing and Intensity of Sound.

As the string during the period A B is carried along by the bow, its velocity during that period is the same as that of the bow. Davis† concludes from this that the tone-power increases with the speed of the bow. For if the speed of bowing increases, then the string will be carried along over a longer distance during the period A B, by which it follows that the intensity of sound will also increase.

It would seem from this as if the intensity of the sound were independent of the pressure of the bow on the string. Davis, however, found each velocity of bowing to require a certain pressure of the bow. If the pressure is too small, the string does not vibrate in the form found by Helm-

---

* How such a bent line may be built up by the summation of sinusoids is demonstrated beautifully by the "Harmonic Synthesizer." D. C. Miller, "The Science of Musical Sounds," New York, the Macmillan Co., 1916, p. 116-7.

† "The Physical Review," Vol. XXVI, No. 4, April, 1908. Davis is wrong where he says that the ratio of A B and B C is the same as that between the distance from the bowed spot to both ends of the string. Obviously he has confounded the bowed spot with that under observation. Let d be the distance of the bowed spot to the nearest end of the string, and l the length of the string, then $\frac{BC}{AC} = \frac{d}{l}$ only when $\frac{d}{l} < \frac{1}{7}$, or when one of the first nodes on $\frac{1}{6}$, $\frac{1}{5}$, $\frac{1}{4}$ or $\frac{1}{3}$ of the length of the string is bowed. Only in those particular cases Davis's rule comes true. (Krigar-Menzel and Raps, l.c., p. 635.)

holtz. A larger pressure than necessary may be used without materially altering the intensity and quality of the sound, but no violinist will use more force than is necessary, as it would soon fatigue the hand, and the sound would easily become somewhat grating.

That for a greater tone-power a larger pressure is required is self-evident. For when the string is moved farther from its position of rest, its tension, or the force tending to carry it back, increases. This greater force can only be overcome by a larger friction or adhesion of the bow to the string, and this can only be caused by increased pressure.*

Connection between Place of Bowing and Quality of Sound.

The position of bowing exerts an influence on the quality of the sound produced. If the string, for instance, is bowed very near to the fingerboard, the end of which is placed at a distance from the bridge of about one-fifth of the length of the string, then the fifth or the sixth overtone is left out, as the string, to produce this harmonic, wants a node in that spot instead of a ventral segment. The quality of the sound is then somewhat veiled.

The normal distance of the bow is about one-tenth or one-thirteenth of the length of the string from the bridge, for a string about 32 cm. long.

---

* A "mechanical violin player for acoustical purposes" has been made by C. V. Raman, Palit Professor of Physics in the Calcutta University. (Phil. Mag., May, 1920, p. 535.) By means of this apparatus the relation between bowing-speed and bowing-pressure can be studied, and several other investigations can be carried on with it. The bow itself remains stationary while the violin is caused to move with uniform speed to and fro. A detailed description of the experimental results is given in the "Proceedings of the Indian Association for the Cultivation of Science," Vol. VI, Part I, 1920.

Harmonics.

For special effects notes called harmonics are used in violin playing.* They can be produced in two different ways:

1. By touching the string lightly by one finger ("loose stop"), by which the string divides itself into 2, 3, 4 . . . equal parts, the number depending on the spot touched. On the A string, for instance, the harmonics A", E", C'" sharp, etc., are produced in this manner. They are called natural harmonics.

2. By pressing the string firmly against the fingerboard with the first finger ("firm stop") and touching the string lightly with another finger, generally the fourth. These are called artificial harmonics.

The peculiar tone-quality of harmonics is not an exclusive property of these notes, however: if the same note is made *on the same string* with a firm stop, its quality of tone is practically the same as that of the harmonic of the same pitch. If, for instance, the G string is touched lightly by the third finger at a quarter of its length from the saddle (being the spot belonging to C′ when playing with firm-stop) then it gives the harmonic G". If this G" is produced by pressing the same finger *firmly* on the string at a quarter of its length *from the bridge*, then the tone-quality of this G″ is practically the same as that of the above-named harmonic G″.

But to make this G″ on the G string with firm-stop and by the fourth finger, the hand has to be placed in the eleventh position. Such high positions are not used in playing. If this G″ with firm-stop is wanted, the E or A string is used, seldom the D, and never the G.

This proves that the flute-like quality of harmonics is not limited to these tones, but that it also appears with firm-stopped tones of the same pitch, if made *on the same string*.

---

* In Dutch and German they are called flageolet-tones, for the similarity of their sound-quality to that of a flageolet or flute.

The easiest way to show this is the following: for producing the G″ with firm-stop on the G string, the finger is pressed firmly on the string at a quarter of its length from the bridge. Now it suffices to remove the pressure and let the finger stay with loose-stop to get the harmonic G″.

That passages with harmonics affect the hearing so differently from common passages is caused simply by the harmonics being played on thicker strings than those used for tones of the same pitch when firmly stopped.

The following simple calculation will plainly show this: if the first finger stops the A on the G string firmly, and the fourth finger touches lightly on D′, the harmonic A″ appears. Now if we take for the length of the string 32 cm., then the length of that piece of the string that gives A″ is $320 \times \frac{8}{9}$ or 284 mm. The string is touched lightly by the fourth finger on D′, being the fourth of the tone A″. The ratio of the length of string of the prime to that of fourth being 4 : 3, the fourth finger is thus resting on a quarter of the length of the shortened string. The string thereby divides itself into four parts of equal length, the length of each part being $\frac{284}{4}$ or 71 mm.

Now if this A″ is stopped in the ordinary way on the E string, the length of the vibrating part of the string is $320 \times \frac{3}{4}$, or 240 mm.

This shows that the vibrating parts of the G string, when giving the harmonic A″, have a length of only 71 mm., whereas the same A″, when played in the ordinary way on the E string, requires a length of 240 mm.

Now, if it be taken into consideration that the thickness and specific gravity of the G string is greater than that of the E string, it is evident that both causes (the shortness of the piece of string and the weight and thickness) co-operate, with the result that the harmonic A″ on the G will be accompanied by fewer overtones than the A″ stopped firmly on the E string.

If the same A″ is played in the ordinary way successively on the G, D, A and E strings, it will be observed, tallying with the above-mentioned, that the

sound is more piercing (less mellow) the higher the string that is used is tuned.

The natural harmonics beyond the simple octave may be made in two different ways. The string may be touched at one-third, one-fourth, one-fifth of its length from the saddle, or at the same distance from the bridge. The last way is generally preferred, as the string is then more easily brought into vibration.*

---

* Richard Scholz, "Die Violintechnik in ihrem ganzen Umfange." Louis Oertel, Hanover, p. 11.

The only book in which I found an attempt to explain the peculiar timbre of harmonics is "Abriss der Instrumentenkunde," by Markus Koch (Jos. Kösel, Kempten und München, 1912). Koch therein says (p. 6) that a harmonic is stronger than the ordinary violin-tone, and also that it receives greater euphony and fullness by the accession of certain overtones. As we saw before, it is exactly the partial *disappearance* of overtones which is the cause of the difference of timbre.

CHAPTER II.

The Bridge and its Motion.

As seen in the introductory chapter, the bridge serves to communicate the vibration of the string to the belly of the violin. We saw also that the amount of air vibration generated by a single string is very small, so that the sound produced is very feeble.

Significance of the Bridge's Motion.

Suppose a bridge standing on the belly of an unstringed violin and under a pressure as large as that of the four strings together, swinging around its right foot and making exactly the same motion as when mounted on a stringed violin and put into motion by the string. Then this unstringed instrument would produce the same tone as the stringed instrument, only a little feebler.

I give this imaginary experiment to show the great significance of this part of the violin; its motion, in point of fact, governs everything. This is made evident already by the great alteration in the tone of a violin, in quantity as well as in quality, when the bridge is hampered in its motion, for instance by being loaded with a mute.

Nature of the Bridge's Motion.

The transmission of the vibration of the strings by the bridge, may be effected in two different ways: (1) by progressive waves, causing each section of the bridge to swing to and fro; (2) by the bridge swinging as a whole.

With heavy bodies, only the first mode of transmission is possible. Let us take as an example a heavy wooden beam, a b, suspended at the middle. If we put a vibrating tuning fork with its stem against the end a, and the ear against b, then the sound will be heard by the ear. This transmission takes place by means of longitudinal vibrations, i.e., vibrations parallel to the longer axis of the beam.

Now suppose it were possible to make the whole beam swing to and fro with the vibrating tuning fork still pressed against the end a. We should then also hear the sound at b, and the acoustic effect would be the same in both cases.

It is evident that the transmission of sound in the case of the beam can only be explained by longitudinal vibration and that the second explanation would be wrong. But with so light an object as the violin bridge it cannot a priori be said how the motion takes place, and both explanations might do.

We will first see what is to be found in the literature on this subject; it will be seen that different authors are of very contradictory opinions and that some have rather singular ideas about it. After that we will deal with the experiments of M. de Haas and the writer.

Huggins* says there are existing in the bridge two kinds of vibrations, one being perpendicular to the other, and that the intersections of the bridge serve to prevent one of these motions passing into the belly. His reasoning does not seem to me to be very intelligible; I fail to see how he was able to determine the direction of the vibrations by means of his "touch-rod."

Helmholtz† says that it is mainly through the left foot that the vibrations of the string are conveyed to the belly, as the right foot serves as point of support to the vibra-

---

* Proc. Roy. Soc., l. c., p. 246.

† Helmholtz, l. c., p. 146.

ting bridge. It cannot be inferred from his description whether the bridge vibrates only in its own plane or also at right angles to it.

Van Schaik* remarks: By the vibrations of the bowed string a motion of the bridge is set up, which consists of an oscillation about a line parallel to the length of the violin: in this way the movable foot of the bridge communicates the vibrations to the belly of the violin and thus to the air. His opinion therefore is that the bridge swings in its own plane, perpendicularly to the direction of the strings.

Savart† says the following of the bridge's motion: "Si on serre le pied droit avec une petite pince en bois ou en fer, le son est plus faible qu'à l'ordinaire, mais moins diminué qu' avec une sordine. Si on pince le pied gauche qui doit imprimer le mouvement à la barre, le son devient incomparablement plus faible. Il est évident que le chevalet produit avec son pied gauche des chocs, qui occasionnent les vibrations de la barre et par suite de la table; le pied droit est, comme nous l'avons dit, assuré et rendu fixe par l'âme."‡

This experiment strikingly proves that the motion, communicated to the belly by the right foot of the bridge, is insignificant. and that the vibration of the belly is due almost entirely to the left foot.

Apian-Bennewitz§ says that it is principally by the left foot that the belly gets its vibrations and that the right

---

* Dr. J. Bosscha, "Leerboek der Natuurkunde II," edited by Dr. W. C. L. van Schaik, fifth edition, p. 170.

† "L'Institut," l. c., p. 92.

‡ Translation: "If the right foot is squeezed in a wooden or iron clamp the tone is weaker than in the ordinary way, but not so much lessened as by a mute. If the left foot, which must communicate the movement to the bass-bar, is squeezed, the tone becomes incomparably more feeble. It is evident that the bridge by its left foot produces shocks which cause the bass-bar, and consequently the belly, to vibrate. The right foot is, as we have said, secured and rendered motionless by the soundpost."

§ Apian-Bennewitz, l. c., p. 131.

foot may be considered as almost motionless. This is quite true, as fully proved by Savart's experiment, but the reason given by Apian-Bennewitz for the smallness of the motion of the right foot is wrong. The reason is not that the A and E strings make smaller vibrations than the other two, nor that they have a greater tension than the lower strings. The reason is to be found almost exclusively in the fact that the right foot is placed in the immediate neighbourhood of the soundpost, i.e., on that part of the belly that is impeded in its motion by the soundpost.

Comparison of the Bridge's Motion with the Function of a Hammer.

Apian-Bennewitz compares the motion of the bridge with that of a small hammer, "dessen Hammerkopf der linke Fuss des Steges bildet."* This comparison is just, if only it be understood that the left foot of the bridge, in its upward motion, never leaves the belly. If it left the belly, this would still reproduce the string's tone in the same pitch, but it would be unable to give the required timbre. For during the short period in which the left foot would be free of the belly, the bridge would not be able to transmit the string's motion to the belly, so that the latter would set up different vibrations from those demanded by the vibrations of the string, with the result that the required timbre would not be produced. The pressure of the left foot only may change periodically, but it should never become zero.

The difference between the effect of the left foot leaving the belly entirely in its upward movement and that of a foot always remaining in contact with it, is the same as that between the function of the old intermittent telephonic transmitter of Philipp Reiss and that of the microphone transmitter as in use at present. The first can only

* *Ibid.*, p. 133.

reproduce the pitch, the second gives also (practically) the form of vibration, and therefore the required timbre, as the contact is never broken.

Apian-Bennewitz further says that the belly is put into vibration by the left foot of the bridge and that the bass-bar disperses the vibrations over a large surface, "so dass zwar vermöge seiner Spannung (the tension of the bass-bar) die Deckenvibrationen der tieferen Saiten entsprechend verlangsamt werden." What is meant here by "verlangsamt" is not quite clear. If taken literally, it would mean that the tones (notes) are lowered in pitch by the bass-bar. He also says that the vibrations of the upper strings are "beschleunigt" (accelerated) by the neighbourhood of the soundpost, which can only mean that the belly will reproduce the tones of these strings at a higher pitch. It is evident that this cannot be true.

Hermann Ritter* calls the transmitting of the bridge's motion to the belly "das Ausladen der Schwingungen" (the unloading of vibrations). The meaning of this rather peculiar expression is made clear afterwards when he compares the motion of the bridge with the running of water through a sluice. I cannot do better than give this description in the original, it is so very curious that it loses much by being translated:

"Um die Funktion des Geigenstegs an der Hand eines Bildes zu begreifen, denke man sich einen fliessenden Bach, dessen Wasser mit der ganzen ihm durch das Gefäll innewohnenden Kraft ein Mühlrad in Bewegung setzen soll. Würde man nun durch zwei von beiden Seiten des Baches ausgehenden Rinnen das Wasser des Baches auf die Seitentheile der Mühlradschaufel werfen, so würde ein bedeutender Theil des Wassers in der Mitte zwischen den beiden Rinnen unbenützt nach unten abfliessen. Wohl würde unter dieser Bedingung das Mühlrad in Bewegung gesetzt werden, aber nicht mit der Kraft, welche auch das

* "Der dreifüssige oder Normal-Geigensteg." Würzburg, Georg Hertz, 1889.

zwischen den Rinnen abfliessende Wasser mit den beiden Seitenflüssen auf das Mühlrad ausüben würde."*

Three-footed Bridge.

The function of the third sluice in the middle of the other two, for want of which the wheel does not get the whole available force from the falling or running water, is performed, according to Ritter, by the third foot in the middle of his three-footed bridge.

If this were true, it stands to reason that using four feet instead of three would be more efficient, and a bridge with only one foot, as broad as the bridge itself, would be better still.

But Ritter did not obtain a good result with a fourth foot, as he tells us, which clearly shows that his reasoning is erroneous.

If one considers from the foregoing how little an able musician, as Ritter undoubtedly was, sometimes understands about the function of the instrument he uses all his life, one will also see how desirable it is that future artists should receive some sound notions of the principles embodied in their instrument. Especially for those who have an inclination to improve their instrument it is absolutely necessary.

Savart† says about the number of feet wanted by the bridge that two are necessary, because of the central line of the belly generally being a nodal line. If the bridge

---

* Translation: "To illustrate the function of the bridge by means of a simile, think of a brook which shall be utilised to drive a mill-wheel by the total force of its fall. If the water were thrown on to the sides of the wheel from two rills issuing from the two sides of the brook, a considerable amount of water would run off unused in the middle between them. Although the mill-wheel would thus be put into motion, it would not be with the same amount of force as if the water running off between the two rills were used in addition."

† "Mémoire," l.c., p. 64.

had only one foot, and that was placed in the middle, it would stand just on that nodal line and thus communicate little or no motion to the belly. He does not say whether with a one-footed bridge the division of the belly would not be such that the central line would form a ventral line, which is not impossible, it seems to me.

Elasticity of the Bridge.

Apian-Bennewitz says that the bridge necessarily should be elastic, and tries to show this by the following example. He assumes two carriages, one on springs, the other without. Of the carriage without springs he says that: "durch die Stösse des Kastens gegen das Radgestell, und umgekehrt, das Gleichgewicht des Wagens und das Wohlbefinden der Fahrenden gestört wird."* To prevent this, springs are used, by which "an Stelle der plötzlichen harten Stösse ein fortgesetztes, gleichmässiges und angenehmes Wiegen des Kastens in den Federn entsteht."†

This example seems to me to be quite wrongly chosen. In the case of the carriage the object is to *prevent* the shocks, which the wheels receive from the impact with the ground, reaching the passengers, and this is attained by means of the springs. But with a violin the motion of the strings should be transmitted to the belly with a high degree of accuracy. Each tone of the string is accompanied by a series of overtones, these becoming weaker in proportion to their distance from the fundamental note. If the

---

* Translation: "By the jolting of the carriage-body against the frame, and vice versa, the equilibrium of the vehicle and the comfort of the riders will be disturbed."

† Translation: "To prevent this, springs are used, by which, in place of the sudden hard jolts, a continuous, even and agreeable rocking motion of the body will result."

intensity of the fundamental is 1, that of the n^{th} overtone is $\frac{1}{n^2}$.* Now it is true that these tones are probably not taken over by the belly with the same intensity, as the thickness of the bridge already exerts an influence over the relation of the intensity of a transmitted tone to that of its overtones. But as shown already on page 14 the belly still reproduces the fifth and the sixth overtone of the string.

This shows that the motion of the string is reproduced by the belly if not with accuracy, at least in its main features.†

If the same result were desired in the case of a carriage, the springs should be left out altogether. The only conclusion to be drawn from this example would be that the bridge should *not* be elastic.

It seems to me to matter little whether the bridge be elastic or not, so long as its elasticity does not influence to an appreciable extent the transmission of the string's motion to the belly, as the bridge is only allowed to make forced vibrations. We shall have to revert to this hereafter.

Returning Vibrations.

Apian-Bennewitz also says that the "Deckenvibrationen .... von der Decke zum Stege zurückkehren."‡ I suppose he means by this that the vibrations, reflected against the rim of the belly or the ribs, coalesce with those spreading out from the left foot of the bridge along the belly, thus producing stationary waves. That there exist

* Helmholtz, l. c., p. 142.

† As to the resemblance of the form of the string's vibration to that of the motion of the air, caused by the violin, see Figs. 142 and 143, D. C. Miller, l.c.

‡ Apian-Bennewitz, l.c., p. 133.

stationary waves is proved by the fact that distinct sand-figures may be obtained on the belly,* whence it follows that some spots are continuously at rest.

Mousson† says on the motion of the bridge: "Die Uebertragung der Bewegung von den Saiten auf die Fläche geschieht gewöhnlich vermöge der Longitudinal-schwingungen des auf hohlem Raume stehenden Steges."‡ With longitudinal vibrations he probably means vibrations parallel to the plane of the bridge.

Experiments of De Haas and Giltay.§

Experiments with a loaded bridge. The bridge possesses two motions, one in its own plane (parallel motion), and one perpendicular to it (transversal motion). Fig. 4 shows a violin bridge. F is the right foot, nearest to the E string. Fig. 5 shows a brass clamp, by which the bridge can be loaded at different points. In order not

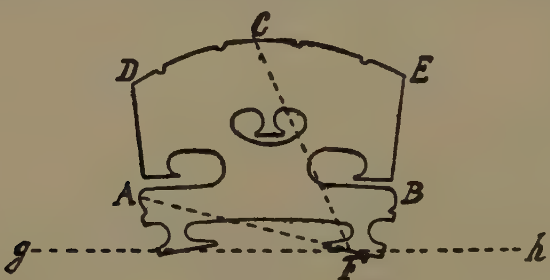


Fig. 4.

* Compare Chapter III.

† "Die Physik auf Grundlage der Erfahrung," 2e Aufl. Bd. II, p. 372.

‡ Translation: "The transmission of the vibration from the strings to the plane (belly) is generally effected by the longitudinal vibrations caused by the bridge, standing on a hollow body."

§ Kon. Akademie van Wetenschappen, Amsterdam. Proceedings of the meeting of December 24, 1909.

to damage the bridge, the screw S does not press directly against the bridge, but against a movable steel plate, d.

When the clamp is placed at A, the difference produced by it in the sound of the violin is insignificant, amounting only to a slight muting of the G string. When placed at B the effect is about the same, only in this case the E string is somewhat muted.

The result of this experiment cannot be explained by the motion of the bridge in its own plane and about its right foot, which motion was shown experimentally by Savart (page 20). That motion should have been hindered much more with the clamp placed at A than when placed at B. For when the clamp is placed at A, the moment of inertia of the loaded bridge, with regard to an axis through the middle of the right foot (F) and perpendicular to the plane of the bridge, is much greater than with the clamp placed at B.

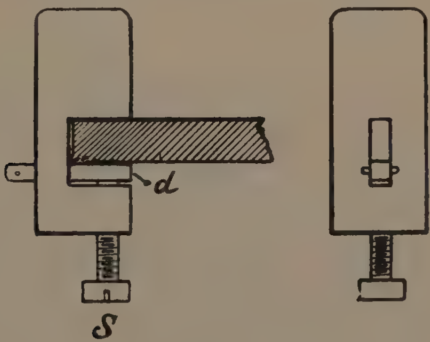


FIG. 5.

Neither can the result of the following experiment be explained by that motion: the distance between the middle of the right foot and the middle of the upper edge of the bridge, F C, in our case was 38 mm. The length of F A was 37 mm. When the clamp is placed at C we obtain a strongly muted sound, the well-known mute

effect, but much stronger than with the ordinary mute, weighing only about 4 gr., as against our clamp, which weighs fully 7 gr. With the clamp placed at A the effect, as said above, was extremely feeble.

As F C and F A are approximately equal, the increase of the moment of inertia of the bridge, by the placing of the mute, is practically the same in both cases with regard to the axis named before. If the sound were transmitted by the bridge only, or chiefly, by its motion about the axis going through F, the damping effect should be the same in both cases.

When the clamp was placed at D the damping was decreasing towards the right, when at E it was smaller at the left side of the bridge. If the bridge swung only about its right foot and in its own plane, the E string in the first case would have to move a bridge of a large moment of inertia which would be impossible without a strong damping taking place.

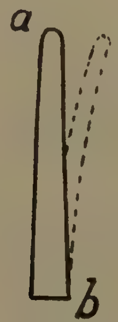


FIG. 6.

As this did not happen, we cannot but infer from these experiments that the motion of the bridge in its own plane is not of primary importance for the transmission of the string's vibration to the belly, and that the bridge also swings transversely, as shown schematically in Fig. 6, giving a transverse section a b of the bridge. On this

assumption the results of all the above-named experiments are clearly explained:

1. A damper placed at A, Fig. 4, has much less damping influence than a damper at C, as the moment of inertia with regard to the axis g h is much less increased in the former case.

2. The effect is about the same whether the damper is attached at A or at B. It is clear that the moment of inertia of the bridge with the clamp attached, has about the same value in the two cases in respect of the line g h.

3. Again, the results of the second set of experiments become intelligible when a transverse vibration of the bridge is admitted: we found in that case that the damping effect diminished towards the right when the clamp is fixed at D, and vice versa. By weighting the bridge at the top corners the vibration is no longer symmetrical; the part which is loaded at the top will vibrate less strongly transversely than the unloaded part.

If the clamp is placed at C, all strings are strongly damped, as the transverse motion of the bridge is then symmetrically impeded.

By damping I mean the well-known effect obtained by putting a mute on the bridge.

The following consideration makes it still more evident that the bridge does also possess a transverse motion. In Fig. 7 d e represents a string at rest, b c the bridge seen from above. When the string is deflected to the right (d a f) it will try to draw the bridge aside and forward, by a force K. We may substitute K by its two components: M, at right angles to the plane of the bridge, and N in the plane of the bridge. From this it follows that the bridge is obliged to make two motions: one in its own plane by the component N (parallel motion), the other at right angles to the plane by the force M (transverse motion).

As soon as the string has reached its greatest deviation, it returns to its position of rest: the bridge will move in the direction c b and also in the direction a f. The string then swings through its position of rest, the parallel

motion of the bridge continuing in the direction c b. *But the transverse motion will now again take place in the direction* f a, until the string has reached its largest deviation to the left, at which moment the parallel motion begins again in the direction b c, and the transverse motion in the direction a f.

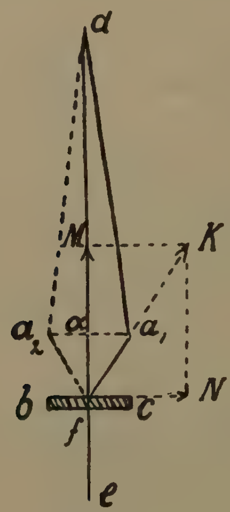


FIG. 7.

This proves the bridge to make two complete vibrations perpendicular to its plane to one vibration of the string itself, whereas the parallel motion of the bridge is of the same period as that of the string.

Except by the force N the bridge may also get a small motion parallel to its plane by the periodical modification of the perpendicular pressure of the vibrating strings. This is probably what Mousson (page 26) means when he mentions longitudinal vibrations of the bridge.

The small twisting motion along its parallel axis which a string receives by being bowed may also communicate to the bridge a slight motion parallel to its plane.

The Parallel Motion of the Bridge transmits all Overtones.

According to Helmholtz* a string, when the bow is applied with full force, vibrates in such a manner that it will produce all the overtones which the stiffness of the string will allow it to emit.

The parallel motion of the bridge causes a periodical change of pressure of its left foot against the belly of the violin. When the bridge moves to the left the pressure increases, and vice versa. As the vibratory period of this motion is the same as that of the string, the vibration of the belly caused by the parallel motion of the bridge is such that the fundamental tone n with its overtones 2n, 3n, 4n . . . . will be heard. If, for instance, a string is bowed, the fundamental of which has a period T, that of the overtones will be $\frac{1}{2}$ T, $\frac{1}{3}$ T, $\frac{1}{4}$ T, etc.

The change of pressure caused by this tone may be represented by the following series:

$$a_1 \sin 2\pi \frac{t}{T} + a_2 \sin 2\pi \frac{t}{\frac{1}{2}T} + a_3 \sin 2\pi \frac{t}{\frac{1}{3}T} + a_4 \sin 2\pi \frac{t}{\frac{1}{4}T} \ldots$$

The Transversal Motion of the Bridge transmits only the Even Partials.

The transversal motion of the bridge also causes a variation of pressure between the left foot and the belly.† When the bridge is pulled forward, the pressure by the front of that foot increases; if the bridge moves backwards its pressure diminishes. As the period of this motion of the bridge is only half that of the strings, the

---

* Helmholtz, l.c., p. 142.

† The same happens with the right foot. As, however, the motion given by that foot to the belly is excessively small, we shall not consider it any farther.

vibration of the belly caused by *this* variation of pressure will be such that only the tone 2n with its partials 4n, 6n, 8n, will be produced.

This change of pressure may be represented by a series of the form

$$b_2 \sin 2\pi \frac{t}{\frac{1}{2}T} + b_4 \sin 2\pi \frac{t}{\frac{1}{4}T} + b_6 \sin 2\pi \frac{t}{\frac{1}{6}T} + b_8 \sin 2\pi \frac{t}{\frac{1}{8}T} \text{ etc.}$$

As the foot of the bridge has only a small surface compared to the large surface of the violin which has to be set in motion, we may assume that the pressure changes which are due to the parallel and the transverse motions of the bridge respectively, occur *at the same point* of the belly. In order to find the total change of pressure produced by both motions together, we must therefore add the two above series. If we assume that the deviation of the belly at the point where the left foot stands is proportional to the change of pressure, the sum of the two series multiplied by a constant will give us also the mode of motion of the belly at that point.

Checking one of the Motions of the Bridge.

It is well known that in general a sound becomes weaker in proportion as the partial overtones become more feeble, and that the intensification of the even overtones especially intensifies the sound. Many instances of this are to be found in Helmholtz's work already repeatedly quoted (p. 129-33 and p. 151-2). As an illustration of the influence of the overtones on a mixed sound, we may also mention the sound of a piano when octaves are played. When an octave is struck on the piano the two notes cannot easily be heard separately, as they can be, for instance, with thirds. But only very slight musical training is required to hear when octave passages are played: the sound is then more intense and harsher. The same holds good for running octaves on the violin.

Now if we have a means of checking one of the bridge's motions, leaving the other as far as possible unaltered, a change of timbre will result. If, for instance, we check only the parallel motion, a_1, a_2, a_3 in our series will decrease, whereas b_2, b_4, b_6 will remain unchanged. This means that the fundamental tone and the odd harmonics are weakened more than the even harmonics. In accordance with the above results of Helmholtz, the sound will thereby be made more intense (less mellow). We have proved this in the following manner by experiment:

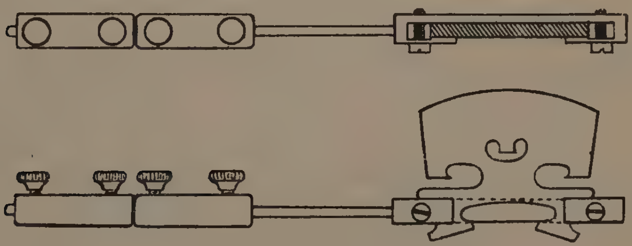


FIG. 8*a* AND 8*b*.

To the bridge of a violin at the lowest possible point a metal clamp, represented half size in Figs. 8*a* and 8*b*, was attached. On the left side (i.e., on the side of the G string) a copper rod 3 mms. thick and 10 cms. long was screwed into this clamp. At the end of this rod two ordinary binding screws were fixed, weighing about 18 grammes each.

The moment of inertia of the bridge about the axis through the right foot, perpendicular to the bridge, was naturally very much enlarged by these weights. The violin now gave a characteristic nasal sound, especially in the G and D strings; the timbre resembling most the note of a hobo.

When in addition to the clamp shown in Fig 8*b* the bridge was loaded with two mutes fixed on top of each other and placed on the upper edge of the bridge, the original sound was approximately recovered, as now the

transverse as well as the parallel motion of the bridge was checked. Of course the response of the violin at this load was difficult. The two mutes were an ordinary ebony mute with a metal mute, as often used, placed on top.

When a_1, a_2, etc., and b_2, b_4, etc., are all diminished in the same proportion, the form of the curve of motion will not change, only the amplitude diminishes: the intensity is weakened, but the timbre remains the same.

If we could diminish the *b's* and leave the *a's* unchanged, the sound would become mellower, as in that case only the even upper partials would become weaker, including the first overtone which has the greatest intensity of all.

The experiment described, p. 25, shows also the influence of checking one of the motions of the bridge: placing the clamp at A (Fig. 4) has but little damping influence, whereas by placing it at C the sound was strongly muted. When placed at A only the parallel motion was checked, the decrease of the transverse motion being very small. When it was placed at C the checking of the parallel motion remained as before, as F C = F A; the transverse motion now being much more checked. According to theory, with the latter position of the clamp the sound was strongly damped: the mute effect, but much stronger than with the ordinary mute.

Effect of the Mute.

A mute placed on the bridge checks both its motions. From the fact that the mute causes the violin to give a weak sound, we may infer that the percentage of the decrease of b_2, b_4, b_6, caused by the mute is larger than that of the decrease of a_1, a_2, a_3, which means that the transverse motion is more checked than the parallel motion by using a mute.

This, then, is the cause of the peculiar weak sound given by a violin with a mute. The same effect, though in a lesser degree, is given by a bridge being too thick or too heavy.

We have also tried to show experimentally that the bridge, as to its parallel motion, swings principally about the right foot, although this has been proved already by Savart's experiment, as mentioned, p. 20.

For this purpose we screwed two metal rings into the clamp of Fig. 8, which were placed in a horizontal position. The violin was fitted with a steel string, which was vibrated electromagnetically. While the string was moving, a small leaden ball was placed alternately in the two rings; the balls weighed 34 grms. each. They were attached to a thin cord; as nearly as possible at the same moment that one ball was lifted out, the second ball was carefully placed in the other ring. We expected that the sound of the violin would be perceptibly weakened as the ball on the right was removed and the left ball simultaneously put in. But we did not succeed in arriving at a trustworthy result in this manner; in the first place, a rattling noise was sometimes apparent while the balls were being exchanged, and in the second place the tone of the steel string was not always of the same intensity.

The conclusion therefore to be derived from our experiments is that the bridge of a violin performs a parallel as well as a transverse motion, and that the timbre of the tone, given by the violin, is modified greatly when the intensity of one of the motions is altered while leaving the other motion unchanged as nearly as possible.

We have thus at the same time given the physical explanation of the action of the mute, and also of the influence which the use of too thick or too thin a bridge has on the sound of a violin.

The action of the mute is commonly described by calling it "damping" or "deadening"*). But if the mute caused nothing but a general damping or reducing of the bridge's motion, the mute would only weaken the sound, and the same effect would be obtained by applying the

---

* Barton, "Textbook on Sound," p. 419: "The mute is a small apparatus of wood or metal which fits on the bridge, and thus deadens the sound considerably."

bow very lightly to the strings of a violin *without*, as by using a firm pressure on a violin *with* a mute. That, however, is by no means the case, as everyone knows.

Photographic Record of the Bridge's Motion.

Barton* has made a photographic record of the motion of the bridge and simultaneously of that of the string. In some cases he found the transversal motion of the bridge having half the period of that of the string. In other cases he found the prime with the octave; in most cases only the prime could be observed.

Edwards† analysed the sound of a violin by means of resonators of different pitch with the use of Rayleigh's mirrors. The mirrors were deviated by the vibration of the air, thereby causing the displacement of the image on a scale. From the size of the displacement the angle was determined in which the mirror was turned by the influence of the sound. He found that by placing a mute on the bridge the overtones became feebler in relation to the fundamental note, and that the fundamental note itself became stronger.

This last-named result seems to me to be somewhat singular. Is it not possible that the player unintentionally bowed faster after the mute was put on, and that this was the reason for the fundamental tone being stronger than before? A surer way, it seems to me, would be to mount the violin with steel strings and excite them electromagnetically. I must own that the relation of the intensity of the fundamental note to that of the harmonics and of the harmonics among themselves would in that case not be the same as with an ordinarily mounted violin.‡

---

*Phil. Mag., September, 1910, p. 463.

† "The Physical Review," CLXXVI, January, 1911, p. 33.

‡ Winkelman, "Handbuch der Physik," 2e Aufl. bd. II, p. 312.

But, after all, Edwards seems to have come to the same conclusion as de Haas and myself, that the harmonics are more enfeebled by the mute than the fundamental tone.

Should the Bridge be Elastic?

On page 25 I expressed the opinion that it does not much matter whether the bridge be elastic or not. Even when not elastic at all, it will be drawn forward, so far as the transversal motion is concerned, by the deflected string. If the string goes back to its position of rest, that part of it behind the bridge which has been stretched and thereby received greater tension, will contract again, and bring the bridge back to its original position of rest. It seems to me this can happen very well without any elasticity of the bridge. It is of course supposed here that the string does not slide over the bridge.

Pattern of the Bridge.

Apian-Bennewitz* gives a drawing of a bridge of the Stradivarius pattern, but unfinished, so that both sides have the same height. He considers the upper rim as part of a circle, constructs the centre of it, and then asserts that every line drawn from that centre through the bridge passes through two openings of the bridge, and, moreover, "dass alle Theile des Steges, die durch Radiën begrenzt sind, gleiche Schwere und die undurchschnittenen Reste aller Radiën ungefähr gleiche Länge haben sollen."† Now if one considers the figure accurately, it will be seen that there are several radii passing through only one opening. But even supposing the bridge to answer all these com-

* Apian-Bennewitz, l.c., Plate I, Fig. 62.

† Translation: "That all parts of the bridge confined by radii must possess equal gravity, while the non-intersected remainder of all radii must be of equal length."

plicated conditions, it seems to me still very doubtful if the excellence of the Stradivarius bridge could be based upon that fact.*

Material of the Bridge.

Hepworth† says that the material of which the bridge is made does not matter, as everything depends upon the weight. It seems somewhat singular, however, that on p. 19 of the same book he says that a bridge of beech-wood is better than one of maple.

A bridge not made of wood, and as far as I know the only one, is manufactured by the H. Bauer Music Company, 135 East 34th Street, New York. This bridge, of very slovenly aspect, seems to be made of ebonite or some substitute thereof. It is pointed out as an advantage that it is "made absolutely without wood": why this should be advantageous it does not say. The pamphlet given with this "H. Bauer's tone-improving chemical bridge" says "it is in no way related to the numerous freak-inventions." A trial showed this instrument might be well placed in the "freak" category; it produces very little difference, if any, from the effect of a wooden bridge; certainly the "chemical bridge" is no better.

Choosing a Suitable Bridge.

Otto‡ has given a simple means for finding a suitable bridge. He makes six different little wood clamps of the form and measurement of the third part of a mute.

---

* The bridge of the old "poche" (kit) shows already a great resemblance to the bridge as used at the present time. See the figure p. 178, Mersenne, "Harmonie Universelle," published 1637. (Stradivarius was born in 1644.)

† Hepworth, l.c., p. 32, 29 ff.

‡ Jac. Aug. Otto, "Ueber den Bau der Streichinstrumente," 3e Aufl., Jena, 1886, p. 28.

The first weighs .12 gr., the second .24 gr., and so forth to .72 gr. Now he puts on the violin a bridge which he knows to be too thin, and then chooses from the six clamps that with which the sound of the violin is at its best. Then he weighs the bridge, and makes another of the same weight plus that of the chosen clamp. Otto is of opinion that the weight is the main point in choosing a bridge.

CHAPTER III.

THE BELLY OF THE VIOLIN.

WE saw in Chapter II that the bridge has the important function of transmitting the vibrations of the string to the belly. To obtain a good result it is necessary that the belly be able to take up all the vibrations the string may give and to reproduce them *all*, and, as far as possible, equally well.

The greater the surface of the belly that takes part in the vibration, the larger will be the quantity of the surrounding air which is set into vibration, in other words, the stronger will be the sound produced by the violin.

Value of the Belly.

The value of a violin depends to a very large extent upon the belly; if that may easily be put into vibration with sufficient, and, as far as possible, equal intensity for all tones given by the violin, then the instrument has a strong and an equal tone.

Hence badly damaged violins sometimes are of great value if they still have a good belly, the violin-maker will then use it to complete a new instrument.

Otto* calls the belly "der vorzüglichste und wichtigste

---

* Otto, l c., p. 250.

Theil des ganzen Körpers."* It is made of pine (Picea excelsa, Link).† The German name, "Resonanzboden," or "Sangboden," is also a proof of the great importance of the rôle performed by the belly.

A new violin not yet varnished gives a louder and mellower sound than a varnished one, but its tone becomes thin and feeble after a short time.‡

To make the vibrating surface of the belly as large as possible, it is constructed in such a manner that it decreases in thickness gradually from the middle towards the rim. The *f* holes also contribute to the increase of sound, as without them the narrow middle part of the roof would be too much hampered in its motion by the ribs, and as it is exactly this part of the belly which receives the motion from the bridge, it is evident that the *f* holes are of great importance in this respect.

Chladni's Sound-Figures.

Before dealing farther with the motion of the belly, we shall first have to consider what is known of the vibration of flat plates of regular form.

If a flat plate of glass, wood or metal is fixed by a clamp in one spot and set vibrating by a violin bow at its edge, stationary waves will appear and a sound will be heard. The plate divides into an even number of vibrating parts, separated from one another by lines of

---

* Translation : "The principal, and most important part of the whole body."

† G. J. Stam. Het hout., Utrecht, 1888, p. 261. H. Welcker von Gontershausen ("Ueber den Bau der Saiteninstrumente und deren Akustik," Frankfurt a/M., 1870, p. 29) says he has found a kind of wood still better adapted for soundboards. He does not know its name, however, and, unhappily, his description is too vague to conclude from it what kind of wood is meant. Can this be Balsa wood? See "Transactions of the American Society of Civil Engineers," Vol. LXXXI, 1917, p. 125.

‡ Vidal, "Les Instruments à Archet," T. I., p. 112.

rest (nodal lines). Two adjoining parts, separated by a nodal line, always vibrate in opposite phases: if one moves upwards, the other will move downwards at the same time. If the plate is sprinkled with a little fine sand, this will be thrown off by the vibrating parts and accumulate on the nodal lines. This method of observing the motion of plates by means of sand-figures we owe to Chladni, who made extensive investigations with regard to this subject.*

On page 47 of his book, Chladni says: "Chaque corps peut faire des vibrations de plusieurs manières très-différentes entre elles, dont chacune a un certain rapport avec les autres, qui dépend de la grandeur des parties vibrantes."† All sections into which a plate divides itself swing with the same period. Farther on he says: "Plusieurs ou toutes les manières de vibration peuvent coexister dans le même corps sonore."‡ As this is given as a general rule, it applies, of course, also to plates. To obtain complicated figures the plate should not be too small (p. 121), as a small plate cannot divide into a sufficient number of sections. The latter applies also to thick or short strings.

---

* E. F. F. Chladni, "Traité d'Acoustique, Paris, 1809. The book was originally written in German, and has been translated by Chladni himself. It was dedicated to Napoleon: "Napoléon-le-Grand a daigné agréer la dédicace de cet ouvrage après en avoir vu les expériences fondamentales." This shows how much interest was taken in these phenomena directly after their discovery. According to Libri, Leonardo da Vinci (1452-1519) was already acquainted with these figures. "Il semble avoir remarqué pour la première fois les mouvements réguliers de la poussière sur des surfaces élastiques en vibration." (Libri, "Histoire des Sciences Mathématiques en Italie," Halle a/S. H. W. Schmidt, 1865, p. 43.

† Translation: "Each body can produce vibrations of several greatly varying kinds, all showing a certain relationship which depends upon the size of the vibrating parts."

‡ Translation: "All or several modes of vibration may co-exist in one and the same sound-body."

Limited Number of Tones given by Chladni's Experiments.

On page 125 Chladni says: "On ne peut pas produire tel son qu'on veut, mais seulement toutes les divisions imaginables, où il peut exister un equilibre des parties entr'elles, et le son de chaque figure (ou espèce de division) est d'autant plus aigu que les parties vibrantes sont petites. Par conséquent on ne peut pas produire sur la même plaque que certains sons, dont les rapports sont très-différents de ceux dont on se sert dans la musique; de manière qu'ici il ne peut pas être question d'octaves, de quintes, etç. La production de ces sons n'a point de ressemblance aux raccourcissemens d'une corde de violon, mais plutôt à la production des sons où la corde se partage en des parties aliquotes et ne peut donner d'autres sons que ceux qui correspondent à certains nombres."*

---

* Translation: "One cannot produce any tone one likes, but only those from all imaginable divisions which stand in a certain ratio to one another, and the tone of each figure (or species of division) is higher by so much as the vibrating parts are smaller. Consequently one can obtain from one particular disc only a limited number of tones which show different ratios from those employed in music; so that there can be no question here about octaves, fifths, etc. The production of these notes bears no resemblance to the divisions (for the stopped notes) of a violin string, but rather to the production of those appearing where the string divides into aliquot parts and cannot give other notes but those which correspond to certain numbers (fractions)."

* Chladni observed that when a little fine dust, such as lycopodium-seed, is mingled with the sand, the ventral lines and their centres, too, are shown, by the dust performing a whirling motion and collecting at the places of most violent vibration. Faraday has shown that this is due to air currents caused by the vibration of the plate. In a vacuum no such effect is seen, the lycopodium then behaving exactly as the sand.

Savart gives the following method for fixing and preserving the sand-figures: pulverised gum arabic and litmus are mixed into paste, dried, and again pulverized. When the sound figures, obtained on the plate with this powder, have appeared, they are

From the foregoing it must not be concluded that a plate vibrated by a bow can only give tones vibrating at the ratio of 1 : 2 : 3 . . . ., in other words, only the fundamental tone and its harmonics. By changing the places of fixing the plate, as well as of bowing and damping (the latter is generally effected by pressing a finger on the plate), a great many more tones may be obtained from it. The following series of tones were produced by Chladni :*

I, From a square vibrating plate.

II, From an oblong plate, the ratio of whose sides was 1 : 2.

III, From a circular plate.

I.

G D E$^1_-$ F^1 B^1 G flat^2 G sharp^2 B flat^2 B^2 C sharp^3 F sharp^3 G sharp^3 G sharp$^3_+$ B flat^3 B flat$_-^3$ C^4 C sharp^4 D^4 F$^4_-$ F^4 F sharp$^4_-$ G sharp^4 G sharp$^4_+$ B flat^4 B$^4_-$ C$^5_-$ C^5 C sharp$^5_+$ D$^5_-$ D sharp^5 E^5 F sharp$^5_+$ G$^5_+$ B flat$^5_-$

II.

D sharp$^1_+$ G^1 A$^2_+$ D sharp^3 F sharp^3 A^3 C^4 D^4 F sharp^4 G sharp^4 A^4 B flat^4 B^4 C^5 D sharp^5 F sharp^5 B flat^5

III.

C G sharp D^1 B^1 C^2 G^2 G$^2_-$ G sharp^2 C sharp^3 D$^3_-$ D sharp^3 E^3 F sharp^3 G sharp^3 B flat^3 B$^3_-$ B sharp^3 C sharp^4 D sharp^4 E^4 E$^4_-$ F^4 G^4 G sharp$^4_-$ A^4 B flat$^4_-$ B^4 C^5 C sharp^5 D sharp^5 F$^5_-$ F^5 F sharp^5 G flat^5 G^5 G sharp$^5_-$ G sharp^5 G sharp$^5_+$ B flat^5 B flat$^5_-$ C^6 D^6 F^6

---

covered with a piece of moist paper, to which they will be transferred by a slight pressure (Müller-Pfaundler, ninth edition, Vol. I, p. 769).

Photographic reproduction of the figures will probably be preferred at the present time.

* Our C is called ut by Chladni, C is ut^1, C^1 ut^2, etc.

The tones given under III were not all produced by the same circular plate. Chladni used for these, plates varying from 10 to 50 cm. in diameter, the smallest for the simplest figures.

It will thus be observed that plates vibrated by a bow can give a very large number of tones, but that they cannot give a complete scale.

This proves that the mode of oscillation of the belly of the violin is not the same as that of a vibrating plate. The belly must respond to the vibrations of every tone produced on the violin. If this is really so, it will have to be explained, except from the shape and material of the belly, chiefly by the different manner in which the motion is communicated either to Chladni's plates or to the belly of the violin. The following experiments of Savart throw light upon this subject.

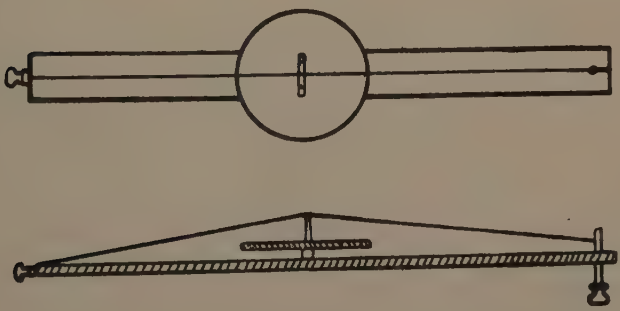


FIG. 9.

Sand-figures Produced by Savart.

The apparatus used by Savart for these experiments is shown in Fig. 9. It consists of an oblong board, to which a piece of cork is fixed in the centre. On this rests a plate of metal or glass, which in turn carries a violin-bridge, over which a string is stretched in the manner

indicated in the illustration. By applying a bow to the string, the plate begins to vibrate, and, when sprinkled with sand, will show a figure the form of which changes with the pitch of the string.

In this way Savart has been able to make a circular plate give a series of tones in chromatic order, from G′ to B″, with a different figure for each tone. (Figs. 10-27.)*

That the belly of the violin, by the medium of the bridge, *is* able to co-vibrate with any tone produced by the strings is undoubtedly true. If this were not so, those tones to which the belly did not respond would be so feeble as to be quite useless.

From the analogy with Chladni's experiments it appeared already probable that the belly of the violin should divide differently for all tones. This probability is made much greater by the above-named experiments of Savart, showing that a plate put into vibration by a string, takes over any tone from the latter, and divides in a different manner for each of them.

The convex surface of the violin, however, makes it difficult to show this by sand-figures.

The pitch of the tone given by a plate vibrated by being bowed at its edge has no direct connection with the motion of the object (the bow) that causes the plate to vibrate.

The manner of division of the plate and the pitch of the tone depends on the spot where the plate is touched by the bow, where it is held by the clamp, and where it is damped, but not upon the motion of the bow. With Savart's experiments the case is quite different: the object (the bridge) that communicates its motion to the plate has itself a periodical vibration. Hence Savart could cause his plate to give any tone he desired, whereas this was not possible to Chladni by applying the bow to the plate itself.

* "Mémoire," l.c., p. 4.

Fig. 10.

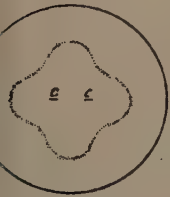


Fig. 11.

Sol$_1$ #

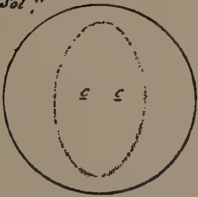


Fig. 12

La$_1$

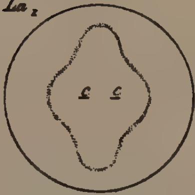


Fig 13

Si$_1$

Fig. 14

Fig 15

Ut$_2$

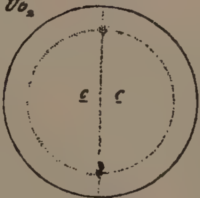


Fig 16

Ut$_2$ #

Fig. 17

Re$_2$

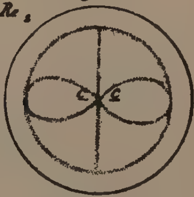


Fig. 18

Fig 19

Re$_2$ #

Fig. 20

Mi$_2$

Fig. 21

Fa$_2$

Fig 22

Fa$_2$ #

Fig. 23

Sol$_2$

Fig. 24

Sol$_2$ #

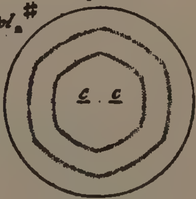


Fig. 25

La$_2$

Fig 26

Si$_2$ b

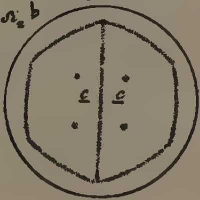


Fig. 27

Si$_2$

Savart's Flat Violin.*

Savart has constructed a violin (Fig. 28) of which both the belly and back were quite flat, as he supposed a flat wooden board, in which the grain runs uninterruptedly throughout its whole length, could be vibrated more easily than a board of curved surface.

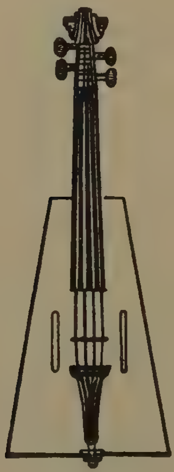


Fig. 28.

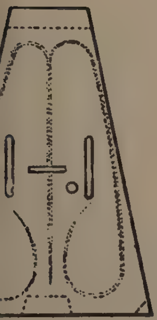
By a board of curved surface I mean one carved and hollowed out from a plank. Curved boards can also be made by flat boards being pressed, but they do not make good bellies for the violin, as practice has shown.

It is because flat boards are more easily made to vibrate than curved ones that, according to Savart, Stradivarius violins give a much stronger sound than, for instance, those of Stainer, the first-named being much flatter.

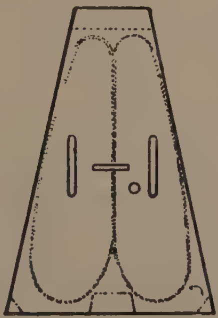
With this flat violin it was possible to show the nodes and ventral-lines of the belly by means of sand-figures.

* "Mémoire," l.c., p. 4.

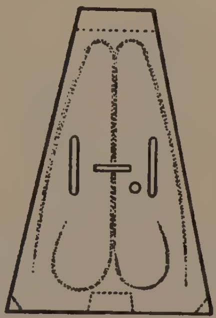
Figs. 29-32 give those figures for the tones of the open strings. They show different divisions of the belly for each of the four tones.



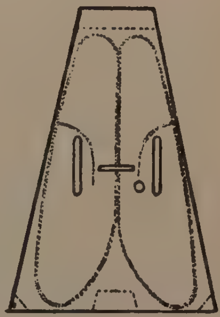
G Fig. 29.



D' Fig. 30



A' Fig. 31



E 2 Fig. 32.

Motion of the Belly.

In accordance with the results of Chladni's and Savart's experiments, we shall henceforth take it for granted that the belly of the violin divides differently for each tone taken over from the strings.*

---

* Löhlein mentions that it sometimes happens that on an otherwise good violin one or more notes are of inferior quality. In his opinion the reason is that those tones cannot find a proportionate thickness of wood in the body of the violin, "denn ich halte es für ausgemacht, dass ein jeder Ton seinen eigenen angewiesenen Ort in dem Resonanzboden eines musikalischen Instruments habe, der durch ihn und keinen andern vorzüglich in Erschütterung gebracht wird." (Translation: "For I consider it a fact that every tone has its fixed place in the resonance-body of a musical instrument which is set into vibration chiefly by that and no other tone.") ("Anweisung zúm Violinspielen, mit praktischen Beyspielen und zur Uebung mit vier und zwanzig kleinen Duetten erläutert," von George Simon Löhlein, zweyte Auflage, Leipzig und Züllichau, 1781, p. 137.)

This conception of the motion of the belly stands midway between that of Maupertuis (mentioned hereafter) and that we have given above.

Barton* found that the belly makes no motion ("is very dead") along the ribs joining it with the back. He found this by sprinkling the belly with a little sand, and also by touching it lightly with the finger-tips. He found the strongest vibration between the *f*-holes in their immediate proximity.

Just as Barton in the case of a common violin, Savart also found in his flat instrument a nodal line very near the rim, as shown in Figs. 29-32.

Huggins† found the vibrations of the belly to be strongest near the left foot of the bridge, and feeblest just above the soundpost.

In the report‡ published by a commission of academicians on the flat violin of Savart, it was presumed that some violins do not respond well to certain notes, because for these the belly divides in such a manner that a node is formed just above the soundpost, and consequently the back is not put into vibration by them. This node, however, must in that case have a surface as large as the cross section of the soundpost, or larger, otherwise the back would still be made to vibrate. (Compare Chapter IV.) That the back also receives more or less vibration through the ribs of the violin seems to have been overlooked.

Maupertuis's Idea about the Motion of the Belly.

Maupertuis,§ president of the Berlin Academy in the time of Frederick the Great, wished the belly of the violin to be made in such a manner that each tone should find a special "fibre" corresponding to it in its vibrations.

---

* Phil. Mag., August, 1909, p. 236.

† Proc. Roy. Soc., l.c., p. 242.

‡ This report is to be found at the end of the "Mémoire" quoted before, and also in the "Ann. de Chim. et de Phys.," T. 12, 1819, p. 225.

§ Vidal, l.c., p. 65.

This can, of course, not even approximately be attained. He seemed to be of opinion that each "fibre" vibrated separately, somewhat like a string, and he even advised that the belly should be made of small strips glued together.

Savart has shown that a plate made in this way shows exactly the same division as before being cut into pieces.*

Heron-Allen† does not agree with Maupertuis's notion of making a belly from fibres glued together; he tersely expresses this by saying: "An idea complimentary to the musical powers of glue, but deadly in practice."

But still the singular idea of Maupertuis that for the lower notes longer fibres are wanted to co-vibrate than for the higher ones, has taken hold of Heron-Allen. Page 150 he says that it will not do to place the soundpost behind the *left* foot of the bridge, "as it would cause the production of short fibre-vibrations where long ones are required, and vice versa."

Vibrations of Homogeneous and Non-homogeneous Plates.

There is a great difference in the manner of vibration of homogeneous and non-homogeneous plates. A wooden disc, for instance, will transmit the waves much better in the direction of the grain than in that perpendicular to it, as each fibre is a tolerably homogeneous body, whereas the fibres are separated from each other by a somewhat softer

---

* This idea of Maupertuis reminds one of the experiments of Graham-Bell, which ended in his inventing the telephone. He took some iron rods, somewhat like the comb of a musical box, and put them into vibration by a neighbouring sound. Afterwards he supplanted the rods by a single iron diaphragm. Graham-Bell therefore followed the same line of thought as Maupertuis, but he began at the other end. (Dumoncel, "Le Téléphone," 1882, p. 52.)

† Heron-Allen, "Violin-making as it Was and Is." Ward, Lock and Co., London, p. 120.

substance. Hence it is easier for the vibrations to follow the grain than to pass from one fibre into another through the soft intermediate substance.

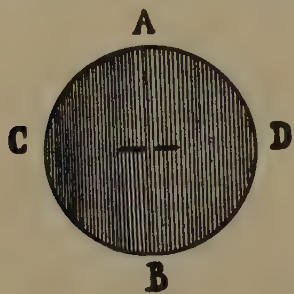


Fig. 33.

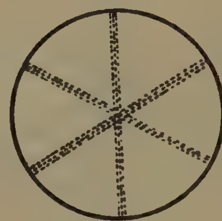


Fig. 34.

Fig. 35.

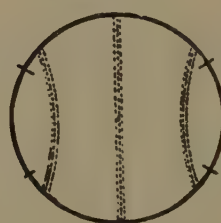


Fig. 36.

If we made a violin with a circular belly, the vibrations would spread much better in the direction of the grain, A B (Fig. 33) than across it, C D. Hence the parts next to C and D would vibrate less than those near A and B. This is one of the reasons for the oblong form of the belly, the longer axis being parallel to the grain. Moreover, a circular violin would be difficult to play, as in playing on the G or E string the bow would easily come into contact with the wood.

The difference in the vibration of homogeneous and non-homogeneous discs has been demonstrated by Savart, who caused plates of different materials to vibrate. Figs. 34, 35 and 36 show the divisions (sand-figures) respectively for a disc of metal, pear-wood and pine-wood.

Composite Motion of a Plate.

On the possibility of causing a plate to make two or more motions simultaneously, Chladni mentions the following*: a disc, no matter of what form, can make several motions at the same time, all tones belonging to those motions being then heard. If a plate is vibrated so that one hears two notes at the same time, no distinct sand-figure ("figure distincte") will appear, because the figure belonging to one set of vibrations will be destroyed by the one which should be produced by the other set.

This becomes clear if we consider that one of the motions will form a node just at the place where the other tries to form a ventral-line or centre. The sand that would remain at rest on a node belonging to the first-named motion will be scattered by the second one, as this is trying to make a ventral-line or loop-centre at the same place.

A distinct sand-figure can only be obtained when the spot where one of the two motions requires a node is touched by a finger which will damp, or arrest, the other motion requiring a ventral-line or loop in that spot. The tone belonging to the latter motion will not be heard in that case.

When a disc is struck in the centre, or set vibrating by a bow without being touched in any spot, several tones will be heard simultaneously, and a clear sand-figure will only appear when some of the motions are impeded.

Chladni's Opinion on the Cause of Difference of Timbre.

Chladni has been very near having found, at least on general lines, the physical meaning of tone-quality or timbre. On page 245 he says that the fundamental tone

* Chladni, l.c., p. 248.

of a string is always accompanied by higher tones, but that every tone given by a string divided into reciprocally equal parts can be obtained without overtones, if the nodes are touched whereby all vibrations are extinguished which would require that part of the string to be in motion. "Il semble que la cause pour laquelle les sons harmoniques d'un violoncelle ou d'un violon sont plus doux que les mêmes sons produits à la manière ordinaire, tient surtout à ce que ces sons ne sont pas mêlés d'autres."* This shows that Chladni not only knew that the sound of a violin or a violoncello, heard as a single tone, is in reality a composite of several tones,† but that he also knew, or at least suspected, that the timbre was altered by the exclusion of one or more overtones, as is the case when harmonics are played on a bowed instrument.

But he seems not to have thought out this point more deeply, as he says (p. 266): "Comme la nature du différent timbre des sons est tout-a-fait inconnue. . . . "‡ The same is said in other words on pp. 47 and 342.§

---

* Translation: "It seems that the reason why the harmonics of a violoncello or a violin are sweeter than the same notes played in the ordinary way, lies chiefly in the fact that they are not mixed with others."

† The existence of overtones was already known to Aristotle; more completely, however, to Mersenne (l.c., pp. 198 and 208-10). Mersenne tried to explain the phenomenon by supposing the overtones to be due, not to the motion of the string itself, but to that of the surrounding air.

‡ Translation: "As the nature of the different timbre of tones is entirely unknown . . . . "

§ Another curious fact, though of less significance, is that on p. 289 the word "téléphone" occurs already. Chladni mentions that Huth proposed to use megaphones to carry messages over a large distance when foggy weather prevented the use of a semaphore. "Un tel téléphone pourrait être utile. . . . . "

Single or Composite Motion of the Plates when Experimenting with the Apparatus of Fig. 9.

The question now presents itself, when a plate is made to vibrate by a string, as done with the apparatus of Fig. 9 by Savart, does the plate possess a simple or a composite motion?

As Savart obtained distinct sand-figures in this way, one might think, after what has been said on page 52, that the plate had only one motion. The string, however, gives with its fundamental tone of n vibrations per second also the overtones 2n, 3n. . . . . Now if the plate really vibrates simultaneously for n, 2n, 3n. . . . . how is it to be explained that Savart nevertheless obtained distinct figures?

That the plate really did co-vibrate for 2n, 3n . . . . cannot be doubted. If this were not so, the belly of the violin would intensify the fundamental note only, and, as the separate sounds of the string, and especially those of its overtones, are by themselves of little account in the compound sound of the instrument, all violins would show the same timbre, as practically only the fundamental tone would be heard. The mute in that case would effect only a weakening of the sound, but no change of timbre.

It appears to me that this seeming incongruity should be explained as follows: the first overtone, 2n, will undoubtedly cause the plate to vibrate, but the intensity of this tone is only a quarter of that of the fundamental tone n (see Chapter II), and the vibration communicated to the plate by that overtone will be too feeble to scatter the sand from the spots where the nodes belonging to the tone n are situated. We should remember that to obtain a sand-figure a plate must receive a certain intensity of vibration; if this is too small, the figure will not appear and the sand will remain at rest.

Small Value of the Sand-figures for Investigating the Motion of the Belly.

As already said, we will take it for granted, in accordance with Savart's and Chladni's experiments, that for each tone of the violin the belly assumes a different division, and that upon this division also depends the timbre of the violin, so that it will not be the same for all instruments, and will be modified even in one and the same violin when, for instance, a mute is placed on the bridge.

It is evident from the above that the correctness of this supposition cannot be proved by sand-figures, even if this were not made impossible by the curved form of the violin. For if the overtones are of sufficient strength to agitate the sand on the belly, no distinct figure will appear, and if they are too feeble only the figures belonging to the fundamental tone will be seen. About the appearance of the overtones, no information will be gathered by this method.

Investigation of the Motion of the Belly by Means of Tuning-forks.

In order to investigate how a resonating body divides itself into nodes and ventral-lines, Chladni proposes to use a tuning-fork giving the same note as that of the body to be investigated. The fork is pressed with its stem lightly against various parts of the body. If a ventral-line is reached, the fork will begin to vibrate, if placed on a node, it will remain at rest.

For examining the motion of the belly of the violin this method seems to me to be impracticable. A large number of tuning-forks would be wanted, and, moreover, the method could not be applied to a violin played on in the usual manner. The violin would have to be fixed in a stand, and the strings made to vibrate, for instance, electro-magnetically, which would bring about another kind of vibration, and consequently other divisions, as said before. In that case, it would perhaps be possible, when the

violin gave, for instance, the tone A′, to determine by means of the forks A′, A″, A‴, the spots where the belly formed nodes and ventral-lines for A′ and its harmonics. But it would probably be very difficult to observe the vibration of the tuning-fork in the immediate vicinity of the strongly-vibrating and sound-emitting belly of the violin. Perhaps this would be possible in the middle of the ventral-lines, but it would no doubt be very difficult to locate the nodes, as, before those spots were reached, the tuning-fork would vibrate so feebly as to be no longer audible. This difficulty would be much greater still for the harmonics than for the fundamental tone A.

It seems to me therefore that it is practically impossible to investigate the mode of vibration of the belly either by sand-figures or by the tuning-fork method. This is a great pity, for if it were otherwise we should have a valuable means for copying the bellies of the violins of the old masters. We should then only have to cut and plane a plank of wood until it showed the same division as the model. As it is, instrument-makers try to copy the old violins by following the measurements very closely and by choosing wood as near as possible of the same quality.*

Resonance of the Violin.

Savart† has determined the resonance-tone of the enclosed air of several of the finest instruments by Stradivarius, Guarnerius and others; he found it in all cases to be c′ (256 whole (full) vibrations).

* According to R. Siebert ("Zeitschrift für Instrumentenbau," year 24, p. 538), the best wood for the belly and the back is that given by a tree that has been deprived of its bark some months before being felled. Instead of copying a belly by taking the dimensions by means of callipers, he uses transparent illumination of the slabs to be compared, and alters the thickness of the new slab till it presents the same transparency as the finished (old) belly. According to the editor of the above-named periodical Siebert has succeeded in this way in making a very good belly.

† "L'Institut," l.c., p. 70.

The instruments were then taken to pieces, and the resonating tone of the belly and also that of the back was determined. For this purpose the belly was fixed in a wooden clamp, the place of the clamp was shifted until the plate showed two nodal lines, one in the direction of the grain, the other at right angles to it, and until the crossing of these lines corresponded with the clamped spot.

The belly was thereby divided into six parts, all of them having the same period of vibration, so that it produced but one single tone.

In this way he found for the belly the resonance-tone, C′ sharp—D′, and, for the back, D′—D′ sharp, thus showing the difference between the resonance-tone of the belly and the back to be only from a semitone to a whole tone.

If this difference were less, Savart adds, beats would appear; if it were larger, it would be difficult to make the belly and the back vibrate in unison. As Savart examined only perfect instruments, he came to the conclusion that any violin in order to be good should satisfy these requirements.

Somewhat later, however,* he says that a very good instrument could be made, the enclosed air of which would give a different resonance-tone, "en le construisant semblable à celui de Stradivarius et en ayant soin d'en prendre les dimensions homologues proportionnelles et telles que leur rapport soit celui des vibrations de l'ut naturel au ton nouveau."†

The report already quoted, says (p. 112) that Savart afterwards improved his violins by taking care that the belly and the back gave the same resonance-tone; to this

* "L'Institut," l.c., p. 92.

† Translation: "By constructing it similar to those of Stradivarius, taking care to use the corresponding proportional dimensions, and in such a manner that their ratio be the same as that of the vibrations of the C natural to the new tone."

he attributed, among other things, the excellence of the instruments of Stainer, Amati, Guarnerius and others. He came to this conclusion by an experiment with the apparatus shown in Fig. 37, consisting of two parallel discs joined by a wooden stem. He observed that, one of the discs being vibrated by a bow, it was much easier to cause the other to co-vibrate when both had the same resonance-tone.

FIG. 37.

This is not in accordance with what he says on p. 70 of "L'Institut," namely, that for a good violin the resonance-tones of back and belly should differ a semitone.

It seems from all that has been said above, that Savart was not very sure about the significance of the resonance-tones of the violin. I shall not speak about the influence of the enclosed air at present, as that will be dealt with in a separate chapter. But it seems to me that the experiments of Savart's concerning the resonance-tones of the belly and the back are of small importance. A board not firmly connected with other parts, but fixed in one nodal-point only, will surely behave in quite a different manner from the way in which it would act if it were fixed along the whole of its rim to the other parts of a complete violin, and then put into vibration from its centre by the medium of the bridge.

It is quite possible that a board of the right sort of wood and the dimensions required for making a good

violin would, in most cases, give the resonance-tone found by Savart. But this experiment can only be of value for examining a board not yet forming part of a violin. There is, in my opinion, not the slightest reason to presume that the resonance tone has much influence upon the tone of the violin, as the belly or the back are entirely differently circumstanced when fixed to the instrument.

But even if those three requirements of Savart as to the resonance-tones of belly, back and enclosed air are fulfilled, it does not follow that the instrument is a good one. Zamminer* found that some very defective instruments fulfilled all these three conditions.

The experiments of Savart can give us, perhaps, a means for condemning an instrument, but not for approving it.

If the belly and the back of a complete violin are made to vibrate by fixing a glass rod to the belly with sealing-wax, and causing this rod to vibrate longitudinally by friction, then, according to Savart,† both belly and back emit a tone of the same pitch as that of the resonance-tone of the enclosed air. This shows the resonance-

---

* Wettengel, l.c., p. 95.

† "L'Institut," l.c., p. 69. "Pour constater ce phénomène et ébranler directement les tables, on colle sur ces-ci verticalement et avec un peu de cire à cacheter des verges de verres qu'on fait vibrer longitudinalement; les tables entrent aussitôt en vibration et produisent le même son qu'on obtient ensuite en mettant l'air du violon en mouvement au moyen du porte-vent appliqué contre le bord d'un des f." (For this "porte-vent," see Chapter IV.)

This does not agree with what is said by Savart in the "Ann. de Chim. et de Phys.," T. 14, 1820, p. 147. He says there that the same tube, when placed on different spots of the belly, will produce sounds of different pitch. He supposes this to be caused by the vibration, communicated by the tube to the belly, spreading only over a part of the latter, and that this part then emits the sound belonging to its particular thickness (and its surface). Only when several tubes are placed on the belly quite near to one another and put into vibration almost simultaneously, can one always obtain the same tone as the belly then vibrates in its entirety.

tones of the belly and the back to have disappeared as soon as these formed part of a complete instrument.*

Since Savart's time much has been written about the tuning of the back and belly. In the (Berlin) "Musikinstrumentenzeitung," No. 41, 1897-8, July 16, appeared a paper of Dr. Max Grossmann, entitled "Wie bestimmt man das Stärkeverhältniss der Resonanzplatten bei der Geige." Grossmann holds the belly between the tips of the thumb and middle finger of the left hand, in the spot where the left foot of the bridge ought to stand. The back is held in the spot where the soundpost is to be placed. He holds the plates very loosely ("freischwebend"), approaches them towards the left ear, and taps the convex arch, or somewhat higher, with the knuckle of the middle finger of the right hand.

According to Grossmann, the belly set in vibration in this way should be tuned to G, if a bright violin tone is wished for. If a less bright tone is desired, it ought to be tuned to F sharp, or somewhat lower down to F. The back to be tuned a fourth or a fifth higher in the scale.

Much has been written about this publication, pro and contra.†

---

* A very good criticism on the conclusions drawn by Savart from these experiments is to be found in Hyacinth Abele, "Die Violine, ihre Geschichte und ihr Bau," Neuburg a/D., Aug. Prechter, 1864, pp. 104-8.

Neither does Simoutre set great store by these experiments. His opinion is: "Dass weder Stradivari, noch irgend ein anderer Meister seiner Zeit sich damit beschäftigt haben, wie Savart meint, Decke und Boden in Einklang zu bringen, den Luftraum ihrer Instrumente zu kubiren und deren Schwingungen zu zählen." (N. E. Simoutre, "Ein Fortschritt in der Geigenbaukunst oder das harmonische Unterlagholz," 2e Aufl., 1887, p. 27.)

Translation: "That neither Stradivari nor any other master of his time occupied themselves with bringing the back and the belly into unison with the cubature of the enclosed air of their instruments nor with the calculation of their vibrations."

† Compare my paper in the Dutch periodical, "De Natuur," 1920, "De afstemming van de bladen der viool" ("Tuning of the Violin-plates").

It would seem to me that the same objection that exists against Savart's tuning experiments applies also to those of Grossmann. Superficially considered from a physical point of view, something might be said for unison-tuning. But in my opinion nothing at all can be said for tuning in fourths or fifths.

Krieckhaus ("The Strad," Vol. XIX, No. 218, June, 1908) is of opinion that Stradivarius always made his bellies almost exactly like each other, as the thickness, he says, is about the same for all, as well as the air volume of the body. After the violin was put together, according to Krieckhaus, the outer surface of the back was worked upon until the instrument gave what was expected. He adds that Stradivarius, by his mastership, undoubtedly knew "where to locate any defect in any tone of an unfinished instrument." This means that he knew, if the instrument was not to his liking, which part of the back had to be made thinner.

He advises violin-makers to give this system a trial. If, however—as probably often will be the case—they have not the necessary knowledge "where to locate," the advice will not be of much use.

As the belly is of much more consequence than the back, it would seem to me that such a manipulation of the *belly* would probably be of more use.

Sadtler says it is not possible for Grossmann's tuned plates to give the resonance-tones he (Grossmann) asserts to have heard. In that case, his violins would be unserviceable, which is not so. He proves this as follows:

The resonance-tone of a Strad belly is about C: its thickness about 2½ mm. Now he calculates the thickness of a board or table tuned to respectively F, F sharp and G, and finds:

F, 1.87 mm. F sharp, 1.77 mm. G, 1.67 mm.

If we call the carrying power of the Strad belly 1, then we find for:

F, .5476. F sharp, .5013. G, .4462.

As sometimes a belly of $2\frac{1}{2}$ mm. proves to be not sufficiently strong to bear the pressure of the strings, it is evident that the above-named bellies are of no use.

Sadtler concludes from this that Grossmann's experiments are totally false and valueless.

Huther ("Zeitschrift für Instrumentenkunde," year 23, p. 640) combats the tuning theory by stating the fact that very good instruments often improve when provided with a stronger bass-bar. As the back is not altered by this proceeding, of course the interval between back and belly receives another value; notwithstanding this, the effect is a good one. Grossmann (l.c., p. 640) says that the proper-tone (resonance-tone) of the roof is not altered by making the bass-bar stronger. This seems to me to be highly improbable.

Rupp (l.c., p. 1,000) remarks that it is rather singular that Grossmann takes the belly on the spot of the left-foot of the bridge, and the back at that of the sound-post, thus causing nodes where the violin shows maximum vibration of belly and back. "It is therefore," he continues, "impossible to implant the tones heard by Grossmann from the loose back and belly into the violin as such."

Passivity.

The roof of the violin should be passive, which means that it should vibrate with approximately the same ease for all the tones of the violin. Hence, the less the influence of the resonance-tones of the belly and the back, the greater the equality of the violin.

Tangential Vibrations.

Before concluding this chapter, we will consider some of the phenomena shown by plates vibrating in the direction of their surface. We will call these vibrations, with Savart, tangential ones; they take place in a direction

perpendicular to that of the transverse vibrations, with which we occupied ourselves till now.

Savart* has observed that plates, rods and membranes, vibrating tangentially, are able to produce sand-figures closely resembling those obtained by Chladni from transverse vibrations.

Vibration-figures Different on the Two Surfaces.

Tangentially vibrating plates show the remarkable phenomenon that the sand-figures on the two surfaces of the vibrating body are not the same. If the body be turned over, the side then uppermost sprinkled with sand, and the body again put into tangential vibration, a sand-figure different from that on the other side will be produced.

Before giving some examples of this, I shall have to mention a general law, established with certainty by Savart, after a great many experiments, as on the justness of this law the working of the different apparatus used by him for his researches on tangential vibrations is based.

All Vibrations in a System of Bodies, joined Rigidly together, take Place in the same Direction.†

In a system of bodies, no matter of what form or what material, joined rigidly together ("un systême de corps unis intimement entre eux") all vibrations take place in the same direction.

Tangential Vibration-figures of a Bar.

If a glass tube is fixed to a bar, in the direction of its parallel axis (Fig. 38), the bar being held in its middle between two fingers, and the tube rubbed parallel to its

* "Ann. de Chim. et de Phys.," T. 14, 1820, p. 124.

† There are two exceptions to this rule, as will be seen hereafter.

length by a moistened piece of cloth, the glass tube will begin to vibrate tangentially. According to the rule given by Savart, the rod will now also vibrate longitudinally or tangentially.* If, then, the upper surface of the

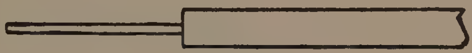


FIG. 38.

bar is sprinkled with a little sand, nodal lines will appear, as shown in Fig. 39. If the rod is turned 180° about

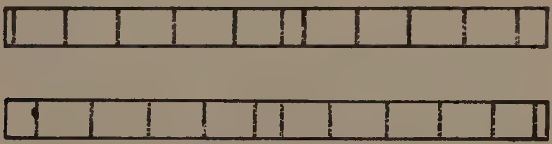


FIG. 39 AND 40.

its longer axis and the surface now uppermost strewn with sand, nodal lines will show, as given in Fig. 40. It will be seen that the nodal lines of one surface are located nearly opposite to the middle of the ventral lines of the other surface.

Tangential Vibration of a Plate.

To show this for a plate or a disc, Savart made use of the apparatus of Fig. 37.† If the stem was made to vibrate transversally by a bow, the discs showed tangential vibrations, parallel to the motion of the bow.

If the discs are of the same dimensions and the same

* "Ann. de Phys. et de Chim.," T. 14, 1820, p. 121, etc.

† "Ann. de Phys. et de Chim.," T. 14, 1820, p. 150.

homogeneous material, the two surfaces facing each other will receive the same division; the same will be the case with respect to the outer surfaces, but the division will differ from that of the inner ones. The upper surfaces

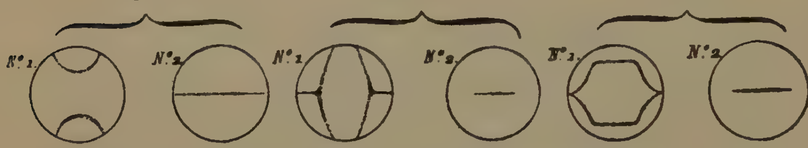


Fig. 41 Fig. 42 Fig. 43

of the discs will thus show different sand-figures. Figs. 41-3 show three sets of figures obtained in this manner by Savart; as will be seen, some of them show a great resemblance to the sand-figures obtained by Chladni from transverse vibrations.

Tangential Vibrations of Membranes.

Savart has shown the same phenomenon to exist when membranes are vibrating tangentially.*

Motion of the Sand caused by Tangential and by Transverse Vibration.

Whether a bar is vibrating transversely or tangentially can easily be seen by the motion of a single grain of sand. Savart† has shown this by means of the apparatus shown in Fig. 44. The upper end of a string e c is made fast to the clamp C, movable about the quadrant DD. The other end of the string, c, is fastened to the rod LL′; the point where it meets the rod is located at the centre of the quadrant.

* "Ann. de Phys. et de Chim.," T. 25, 1824, p. 29, Pl. 1.

† "Ann. de Phys. et de Chim.," T. 25, 1824, p. 145.

Now if the string is made to vibrate longitudinally and placed as the figure shows, a grain of sand lying on the rod will jump vertically and fall down nearly on the same spot from which it started. If the clamp C is moved along the quadrant, the string thereby leaving its per-

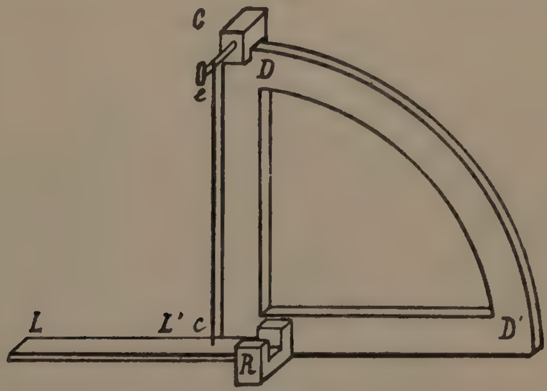


FIG. 44.

pendicular position towards the rod LL′, the grain of sand will not jump so high as before, and will not fall back on the same spot. The more the clamp is moved downward, the greater will be the distance of the point from which it jumps up from that in which it falls down, and the lower will it jump. If, finally, the string is placed horizontally, in the direction of the rod, the sand will not leave the bar at all, but will only glide over the surface.

Tangential Vibrations Emit very Little Sound.

As seen before, when treating on the motion of the bridge, the belly of the violin vibrates by that motion transversally. It is not impossible that the left foot of the bridge imparts also feeble tangential vibrations to the belly, but at all events these can be of but small im-

portance, and the sound produced by them is probably of negligible quantity, the more so as a tangentially vibrating plate emits much less sound than a transversally vibrating one. This is evident, when it is considered that a tangentially vibrating plate can transmit its motion to the surrounding air only by its edge; the air near the surface can only be made to vibrate by friction, which motion naturally is of no consequence. A transversally vibrating plate, on the contrary, can transmit its motion to the air by the whole of its vibrating surface.

Savart* has shown this experimentally in the case of a rod, by means of the apparatus shown in Fig. 45. c e is a tensed string, LL′, a thin and narrow rod of wood or glass, glued in its middle to the string. Between the foot of the apparatus and the rod, some soft body, a piece of cork, for instance, is placed to prevent the rod from swinging when the bow is applied to the string. Now if the

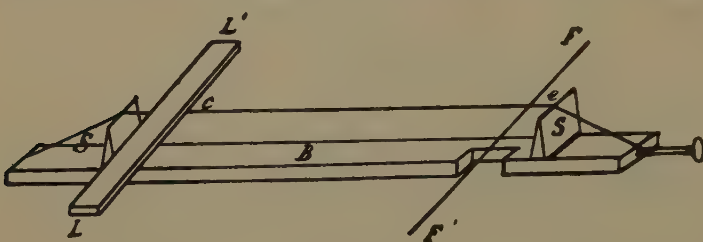


Fig. 45.

bow is moved in the direction FF′, the rod will vibrate longitudinally (tangentially). If the direction of bowing is altered, taking care, however, that it remains perpendicular to the string, the sound will get stronger the more the direction of bowing approaches to the vertical, as the vibrations then are gradually becoming transverse.

If the belly of the violin were made to vibrate tangentially, the greater part of the ribs would vibrate transversally.

* "Ann. de Chim. et de Phys.," T. 25, 1824, p. 34.

Savart's Law not Applicable to the Violin.

As the different parts of the violin cannot be said to be rigidly united together, Savart's law that all vibrations in the different parts take place in the same direction cannot be applied here. For the bridge cannot be said to be rigidly united to the belly, and especially its left foot possesses a certain degree of freedom.*

In spite of this, I thought it best to mention these experiments of Savart's, as they help to widen our view on the subject of the vibration of plates. We shall, moreover, have to recur to tangential vibrations in the next chapter, when quoting Savart's opinion of the function of the sound-post.

Savart has treated these subjects very elaborately; one would be apt to consider his treatment to be somewhat prolix. But after a careful perusal the reader will find that he has gained much.

Exceptions to Savart's Rule.

Savart mentions two exceptions to his rule that all vibrations in a certain system take place in the same direction.

1. When one plate is placed perpendicularly on another, just on the spot where the latter is prevented from vibrating by some cause or other.†

He has shown this by means of the apparatus, Fig. 46. The plate A′ is placed on a node of the plate A, and the point N is prevented from vibrating tangentially by the block C. If, then, A′ is strewn with sand and A set vibrating transversally by a bow, the sand will show that A′ does not make tangential vibrations, but that it vibrates transversally, just like A.

---

* We shall have to return to this subject again later on.

† "Ann. de Chim. et de Phys.," T. 14, 1820, p. 158.

2. The second exception was shown by means of the apparatus given schematically by Fig. 47: a string, fastened perpendicularly to a thin board. If the string is made to vibrate transversally, it will, in general, according to Savart's rule, transmit a tangential motion to the board; as the vibrations of the string take place in the direc-

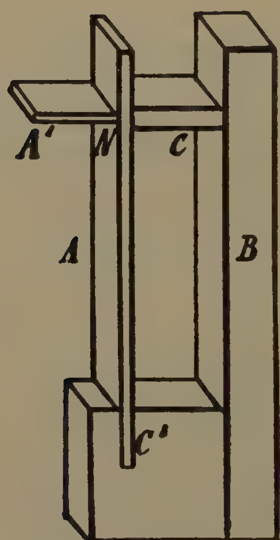


FIG. 46.

tion in which the bow moves, these tangential vibrations of the board may be caused in any desired direction. When, however, the note of the string is the same as that of the transversal note of the board, transverse vibrations will be set up in the latter.*

* "Ann. de Chim. et de Phys.," T. 25, 1824, p. 147.

Savart attributed this to the transmission of the vibrations by the air. This seems to be to be very improbable, as the motion of the air, caused by a single string, is almost negligible.

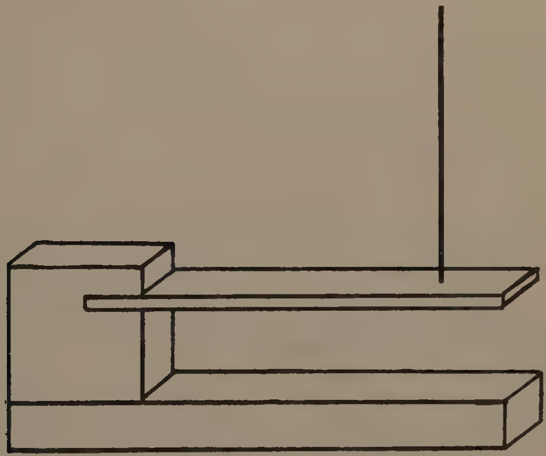


FIG. 47

If the pitch of the string were that of the lower octave of the transversal-note of the board, it would be obvious that the board would set up transverse vibrations, as we should then be in the same case as with the double vibrations of the bridge. I suspect that Savart has mistaken the octave here.*

* This rule of Savart's is also not applicable to the vibration of a bell. If this is put into motion by vibrations the frequency of which correspond with that of the bell's proper vibration, it will vibrate *radially*. Although the different parts of the bell may be said to be firmly connected together, still in this case the vibrations do not all take place in the same direction.

CHAPTER IV.

THE SOUND-POST.

NEAR the right foot of the bridge, a wooden rod is wedged in, standing upright between the belly and the back. This rod, called the sound-post, has a great influence on the sound of the violin, its length and the place where it ought to stand are to be determined individually for each violin.

The name "sound-post," and still more the French "l'âme," and the German "die Seele" or "die Stimme," also show the great significance of this part of the violin.*

Length of the Sound-post.

According to Hepworth,† the length of the sound-post should be such that its position may easily be shifted when the strings are taken off the violin, without falling, however, when their pressure is released.

---

* The Dutch name is "stapel," meaning a prop or support. It also means "Stock," f.i., "the ship is on the stock" in Dutch is, "het schip staat op stapel." Van Nierop also names the movable bridges used for shortening the strings of the sonometer "stapelkens," and uses the verb, "stapelen," for shortening the string by means of these bridges. (J. R. van Nierop, "Wis-Konstige Musyka," Amsterdam, 1659, p. 23.)

† Hepworth, l.c., p. 41.

According to Maugin and Maigne,* when the sound-post is too short, the sound of the lower strings is too strong compared with that of the other strings; in many cases the equilibrium between the strings may be restored by taking the sound-post somewhat longer.

Wettengel† explains this as follows: when the sound-post is too short, and hence the pressure against the belly and the back too small, the resonance-tone of the enclosed air becomes lower, and the lower strings are "begünstigt" (favoured). If the sound-post is too long, the resonance tone becomes too high, and the sound of the A—and especially that of the E—string is strengthened.

It appears to me that this variation of the resonance-tone of the inner air body caused by a change in the length of the sound-post will be extremely small, and that the strengthening of the higher or lower tones cannot be attributed to a variation of the resonance-tone. The reason for this lies probably in the greater or lesser rigidity of the belly, and the consequent difference in the divisions of the latter.

Adjustable Sound-post.

According to the violin-maker Stoss of Vienna, it would be of great importance if some contrivance could be found by which the length of the sound-post, after being placed in its position inside the violin, could be altered at will.‡

Diameter of the Sound-post.

When the sound-post is too thin, the sound of the violin is shrill and thin.§ Hepworth gives 6 mm. for its

---

* "Le Luthier, Encyclopédie Roret." Paris, "Librairie Encyclopédique Roret," 1894, p. 130.

† Wettengel, l.c., p. 95.

‡ Hepworth, l.c., p. 43. Abele, l.c., p. 169.

§ Luthier, l.c., p. 384.

diameter. According to Otto, the sound-post should be made as thick as the opening of the *f*-hole, through which it is to pass, permits.*

Influence of the Material of the Sound-post.

Huggins† has made a sound-post the middle of which consisted of a leaden cylinder 13 mm. long, of the same diameter as the wooden parts of the post. The sound emitted by the violin when using this sound-post was about as strong as with the usual sound-bar, but the quality of the tone was much altered. Huggins concludes from this experiment that the material of which the sound-post is made, is of great influence, which is also the opinion of all violin-makers.

Position of the Sound-post.

If the position of the sound-post is changed, the division of the belly will also be altered, just as in the case of Chladni's plates, when the position of the finger touching the plate is changed.

According to Hepworth, the true position of the sound-post is shown by the Figures 48 and 49. Fig. 48 gives the sound-post seen in a direction perpendicular to the plane of the bridge; it is then seen just under the middle of the right foot of the bridge. In Fig. 49 it is seen from a point in the plane of the bridge; the front edge of the sound-post coinciding with the back of the bridge.

If other authorities are heard, however, it would seem that Hepworth is too positive in this, just as we found him in Chapter I, when quoting his opinion on the equality of tension of the strings.

According to Savart‡ and others, the position of the sound-post has to be determined for each instrument sep-

---

* Otto, l.c., p. 21.

† Proc. Roy. Soc., l.c.

‡ Luthier, l.c., p. 384.

arately. If placed too near the back of the bridge, the sound of the violin is rough and loud; if the distance is too great, the sound is dull and hollow.* If placed too much to the right, i.e., too near to the right *f*-hole, the sound of the higher strings is too strong compared with that of the lower ones, the reverse being the case when it is placed too much to the left.

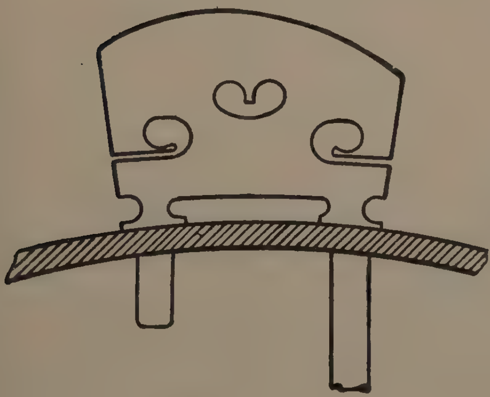


FIG. 48.

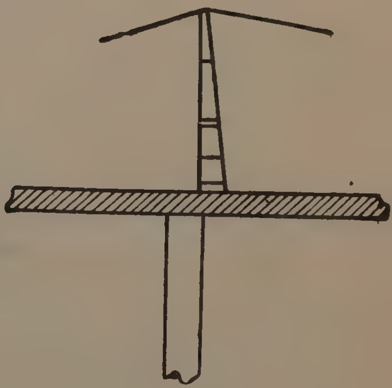


FIG. 49.

Otto says that for a well-constructed violin the sound-post should be placed 11 mm. behind the right foot of the bridge. For inferior instruments it has sometimes to be placed a little farther back, and sometimes also somewhat more to the right.

Functions of the Sound-post.

As we have seen, the sound-post forms an important accessory of the violin, and much depends upon its position, its dimensions and the material of which it is made. We will now examine its functions.

---

* Adler, "Die Behandlung und Erhaltung der Streichinstrumente," p. 14.

1. The sound-post diminishes the motion of the belly at the place of contact. Hence the motion of the right foot of the bridge is very small, as it is placed quite close to the sound-post.

2. It causes the belly to assume such divisions as are requisite for the production of a good tone.

3. It transmits the motion of the belly to the back.

4. It enables the belly to bear the pressure of the strings. Without a sound-post the right half of the belly, not being strengthened by a bass-bar like the other half, would be pressed in.

The Sound-post does not give a Node to the Belly.

The formation of a node on the roof by the sound-post seems to me to be improbable. For this it would have to rest on a solid, non-elastic body. The back, however, is made of a thin board, more or less elastic, so that it will not be able wholly to extinguish the motion of that part of the belly which the sound-post touches, but will take over some of the motion, and thus co-vibrate.

But even if the place of contact between sound-post and belly produced a node, be it a circular or a rectilinear one, the back would still be made to vibrate by the sound-post. Savart* has proved this by means of his apparatus shown in Fig. 37. The upper disc was set vibrating by a bow in such a manner that it showed a single nodal line coinciding with one of its diameters. It was then seen that the lower disc took the same form of vibration. Savart proved that the vibrations were not transmitted from one disc to the other by the intervening air, by placing between the two discs another thick wooden disc having a hole in its centre large enough for the rod to pass freely. The lower disc then behaved just as before.

Then he applied the bow to the upper disc in such a

* "Mémoire," l.c., pp. 7 and 28.

manner that a circular nodal line appeared, and in this instance also was the same phenomenon observed on the lower disc.

For Savart's explanation of this phenomenon I refer to the "Mémoire," p. 8.

If the back were quite immovable in the spot where the sound-post rests, the latter would not be set into tangential (longitudinal) vibration by the transverse vibrations of the belly, according to what is said, p. 69, sub. 1. In that case the sound-post would vibrate transversally.

The Sound-post Diminishes the Motion of the Belly.

According to Savart,* the sound-post does not alter the motion of the belly and the back, as it does not press against them.

This does not seem to be correct. If the sound-post transmits the motion of the belly to the back, the motion of the belly near to the sound-post will be diminished, as the motion of the back can only be caused by a loss of energy of the motion of the belly, from which it necessarily follows that the vibrations of the belly will become more feeble. We shall revert to this in Chapter V.

The Sound-post Transmits the Motion to the Back.

As seen in Chapter III, Huggins found the vibration of the belly, as well as that of the back, to be feeblest near the sound-post. After having removed the sound-post, the vibration of the belly was equally strong on each side of the bridge; the sound of the violin, however, was "poor and thin," as is well known. *The vibration of the back was then very small.*

We may conclude from this that the motion of the back is largely owing to transmission by the sound-post, and that the ribs of the violin and the enclosed air are of little moment in this respect.

---

* "Mémoire," l.c., p. 39.

Substitution of the Sound-post.

Savart* has made several experiments, substituting the sound-post by a pressure from the outside of the violin. An arched piece of wood was glued to one of the corners of the violin, and a sound-post wedged between that piece of wood and the upper side of the belly, over the spot where the sound-post usually stands. He obtained thus, as he says, the same effect as with the usual sound-post.

Instead of a sound-post between the wooden arch and the belly, he then fixed a screw; if this was pressed against the belly, the effect of the sound-post was obtained, but in a still higher degree. The same result followed when glueing the arched piece of wood to the under side of the violin, and causing the screw, which passed freely through a hole in the back, to press against the inner surface of the belly.

A violin without sound-post was then taken by Savart and loaded by a weight in the spot where the sound-post usually stands: the effect was the same, provided the weight surpassed a certain limit. The same experiment may be made with a test-tube filled with quicksilver.

Finally, he used a wooden clamp reaching over the belly and under the back, with a screw at each end. If both screws were made to press against the belly and the back respectively, the effect was again the same as with the usual sound-post placed inside.

That the sound-post acts principally upon the belly was proved by Savart by taking a violin without back, and provided with a wooden transverse bar, carrying a sound-post. The effect of removing the sound-post was the same in this case as in that of a complete violin.

Huggins† has made the same experiments. With the

---

* "L'Institut," l.c., p. 55.

† Proc. Roy. Soc., l.c. Huggins was not acquainted with these experiments of Savart's, compare the foot-note, p. 243 of his paper.

clamp with two screws—one pressing against the belly, the other against the back—his violin emitted about the same sound as when provided with a sound-post; the back, too, vibrated almost as strongly as with a sound-post in its proper place. When using only one screw, pressing against the belly, he found "the tone was altered in the same direction as when the sound-post was present, but it was not until the lower part of the clamp was also in contact with the back that the normal character of the tone was fully restored." A wooden rod pressing against the belly showed the same effect as when only one screw was in contact with it.

Whereas Savart concluded that the action of the ordinary sound-post could be entirely replaced by pressure upon the belly, Huggins came to the conclusion that the full effect could only be obtained when the pressure was exerted on the back and the belly simultaneously, thus showing only a gradual difference with Savart's results.

From Huggins's observations it would follow that the sound-post, after all, transmits to some extent motion from the belly to the back, which is also my own opinion.

It seems to me that these experiments cannot have been very accurate. To judge the intensity, and still more the tone-quality of a violin, it is necessary to play it in the usual way, without hindrance. How can this be possible when, f.i., the violin is weighted with a tube filled with quicksilver?

The Sound-post Acts Principally on the Belly.

The experiments described show, at all events, that the function of the sound-post for transmitting the vibration to the back is not of great importance, but that it serves principally to enable the belly to assume the correct divisions required for emitting sounds of good quality.

Motion of a Belly without Sound-post.

If the sound-post is removed, the right foot of the bridge rests on an elastic spot, just like the left foot; the bridge will then swing round a point situated midway between the two feet. When one foot goes up, the other goes down simultaneously. It is obvious that with such a motion of the bridge, that of the belly will be altogether different from that made with the aid of a sound-post.

I have tried a very ordinary violin (the same that has been used for the experiments of Fig. 53), after having removed the sound-post. The sound given by it was very remarkable; especially when the bow was applied lightly to the D string, it bore a striking resemblance to the sound of a hobo. It could not be said, however, to be unmusical.

If the sound-post only served to support the right foot of the bridge, it would have to be placed exactly under that foot. But, as is well known, the sound of the violin is then very bad.

Sound-post for Supporting the Belly only.

Huggins has also tried to make a sound-post that supported the belly but did not transmit the vibrations of the belly to the back. For this purpose, he took a small wooden rod, ending both sides in a disc of rubber. This sound-post was sufficiently firm to steady the belly, but its power of transmission was very small, as shown in the following manner: the stem of a vibrating tuning-fork was placed on one of the rubber discs of this sound-post; the other disc being in contact with some object fit to co-vibrate, and thus strengthen the sound. The experiment showed that the sound became but very little louder by using this system.

This sound-post, then, being unfit to take up the vibra-

tions of the belly, was put into a violin; it appeared that the instrument gave about the same sound as that of a violin without any sound-post.

Huggins concludes from this that the ordinary sound-post serves not only as a prop for the belly, but also as a transmitter of the vibrations to the back. As this sound-post with the rubber discs, he says, transmits practically no vibrations, the back does not co-vibrate, and hence the sound is as feeble as that of a violin without any sound-post at all.

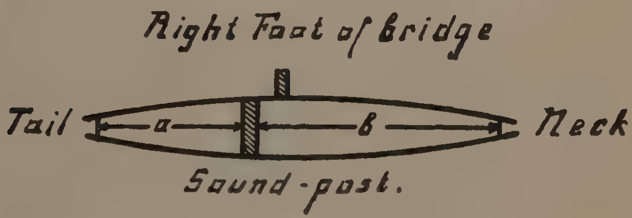


Fig. 50.

This conclusion is wrong, as it seems to me. That a violin with a sound-post with elastic (rubber) ends produces a tone of inferior quality is not caused by the back being almost non-co-vibrating. The cause lies in the fact that the belly is not completely checked, and hence does not assume the proper divisions. The conclusion of Huggins's does not accord with the results of his own experiments with the clamp and the screws as a substitute for the sound-post. Savart's experiments with the test-tube filled with quicksilver has proved, at all events, that a certain pressure is wanted to obtain the sound-post effect; if the pressure is not sufficient, this effect does not appear. It is obvious, therefore, that the inferior quality of the sound of the violin with Huggins's sound-post is to be attributed to its pressure on the belly being too small, owing to the elasticity of the rubber discs, and that it cannot be attributed to insufficient co-vibration of the back.

The Right Foot of the Bridge Transfers only very Little Motion to the Roof.

That the right foot of the bridge, owing to its vicinity to the sound-post, transmits only very little motion to the roof, becomes evident when considering Fig. 50, showing a longitudinal section of the violin through the middle of the sound-post. In order to communicate a considerable motion to the part b of the belly, the right foot should be placed in the middle of b. In point of fact, it is situated near the end of b. The left foot, on the contrary, is placed at about equal distance from both ends of the instrument, as is shown in Fig. 51, being a

FIG. 51.

longitudinal section of the violin through the left foot, and hence in a very favourable condition to communicate vibrations quickly to the belly.

Transposition of the Sound-post.

As said on p. 75, the sound of the violin is altered as soon as the place of the sound-post is changed.

This is obvious, as by so doing, the motion communicated to the back and taken from the belly is altered, as well as the division of the latter in respect of nodes and loops or ventral-lines. The latter factor will, in my opinion, have by far the greater consequence.

Savart's Theory on the Function of the Sound-post.

According to Savart,* the sound-post causes the belly to vibrate transversally.

As seen on p. 64, he gave as a general rule that all vibrations in a system of rigidly joined bodies take place in the same direction. If we consider the body of the violin with bridge and sound-post as such a system, then the strings, swinging in a direction nearly parallel to the surface of the belly, will cause it to vibrate tangentially.

As the belly, however, swings transversally, as Savart knew, he gave the following explanation of this contradiction. He had found experimentally that a plate, connected perpendicularly with a rod vibrating longitudinally, will in some cases vibrate tangentially, while according to the general rule one would expect transversal vibrations. Inversely, in such a case, the tangentially vibrating plate will cause the perpendicular rod to vibrate longitudinally.

This, according to Savart, is exactly what happens with the violin. The belly is made to vibrate tangentially by the strings, and these tangential vibrations will set up longitudinal vibrations in the sound-post, which in their turn will again cause the belly to vibrate transversally.

This intricate explication seems to me to be incorrect as well as unnecessary. *Incorrect*, because the body of the violin with the bridge cannot be considered as a system of bodies rigidly connected. Only in the case of the belly consisting of a thick wooden board, not appropriate to divide itself into sections in the manner of Chladni's plates, in order to make transverse vibrations, would the belly be caused to vibrate tangentially by the bridge. The same would probably be the case if a sound-post were placed under each foot of the bridge. But as this is not the case, Savart's rule is not applicable here.

* "L'Institut," l.c., p. 55.

The theory of Savart seems to me to be *unnecessary*, as the simple explanation, given in Chapter II, of the function of the bridge, is sufficient in every respect and wholly in accordance with the results from the experiments with the loaded bridge. I thought it necessary, however, to mention this theory, because it is still given without any criticism by several authors, as, for instance, in the book of Wettengel-Gretschel previously quoted.*

Heron-Allen† says: "The object of the sound-post is not so much to communicate the vibration of the belly to the back, as to render the vibrations of the two plates similar (or normal), *whilst* it communicates them. . . . . The sound-post has, therefore, the same effect upon the belly and the back as the bow has on the strings; it continues the vibrations and keeps them regular with one another. The succession of shocks given to the strings by the bow are communicated to the back by the sound-post . . . " etc.

This is somewhat in accordance with what Savart says. The latter part of the quotation is rather hazy.

---

* For Savart's further experiments for proving his theory of the function of the sound-post, I refer to his lecture in "L'Institut."

† Heron-Allen, l.c., p. 151.

CHAPTER V.

THE BACK.

WE will now consider the function of the back of the violin.

Significance of the Back.

We have seen in Chapter III that the value of the violin depends chiefly on the belly; in other words, that the back is of less significance.

Auerbach* says that everything depends upon the wood and chiefly "da es auf den Boden weniger ankommt" (as less depends upon the back) on the wood of the belly.

Schubert† says: "Die in der Mitte ausgeschweifte Resonanzdecke . . . . ist der Theil auf dessen Beschaffenheit das Meiste für die Güte des Tones ankommt."‡

Otto§ says: "Der Boden hat schon mehr Einfluss auf die Ausbildung des Tons als die Zargen, wie wohl die von Einigen ausgesprochene Meinung unrichtig ist als komme auf ihn das Meiste an bei der Formation des Tons. Denn allerdings gehört er zu den Hauptstücken des In-

---

* Felix Auerbach, "Die Grundlagen der Musik," 1911, p. 103.

† F. L. Schubert, "Die Violine," fourth edition, p. 21.

‡ Translation: "The resonance-board (belly), curved in the centre . . . . is the part upon whose nature the quality of the tone chiefly depends."

§ Otto, l.c., p. 14.

struments, jedoch gehört seine Thätigkeit nur dahin, die Vibrationen, in welche die innerhalb des Körpers eingeschlossene Luft durch die Schwingungen der Decke versetzt ist, in entsprechenden Schwingungen anzunehmen und wieder zurückzustossen."*

Of all authors known to me, Bagatella† is the only one who sets more value on the back than on the belly. He says: "Ueberhaupt muss man besonders vorsichtig bey dem Holze des Bodens seyn, weil von dem Boden grossentheils die Güte des Instruments abhängt."‡

Vidal asserts that the only use of the back is to limit the volume of the enclosed air in the body of the violin, but that otherwise it has no influence on the formation of the tone.

Violin without Back.

Savart§ goes farther still, and seems to attach little or no value on this limitation of the volume of the enclosed air. He says: "Quand on supprime le fond, le son est un peu plus faible que quand on ne fait que suprimer l'âme. J'ai vu avec beaucoup d'étonnement que la differ-

* Translation: "The back has already more influence upon the formation of the tone than the ribs, although the opinion expressed by some, that it is of primary importance in that respect, is erroneous. It is true that it belongs to the principal parts of the instrument, but its function is only to receive and repercuss in reciprocal vibrations those communicated to the air, enclosed in the sound-body, by the vibrations of the belly."

† Antonio Bagatella, "Ueber den Bau der Violinen, Bratschen, Violoncells und Violons." Translated from the Italian by J. O. H. Schaum. Leipzig, A. Kühnel. This translation is without date. A prize was awarded to Bagatella for this book by the Academy of Padua in 1782; it was published there in 1786.

‡ Translation: "Altogether, one must be particularly careful about the wood of the back, because the quality of the instrument depends chiefly upon the back."

§ "Mémoire," l.c., p. 56.

ence n'était pas grande: il a beaucoup moins de mœlleux mais l'intensité en est peu diminuée."*

As this refers to his "violon trapézoidal," it cannot be concluded from this experiment that the back is also of little value to the common violin.

I presume that in this experiment Savart left out the sound-post as well as the back; no mention is made at least of a traverse bar which would be required in that case for carrying the sound-post.

That the suppression of the back, after having suppressed the sound-post, does not much diminish the intensity of the sound, cannot be wondered at, as the transmission of the motion of the belly to the back takes place by far the greater part through the sound-post, as we have seen, because the function of the enclosed air and that of the ribs of the violin-body is of little consequence in this respect. Hence, as soon as the sound-post is removed, the vibration of the back is very feeble, and its suppression cannot cause the sound to become considerably weaker.

Savart seems to have forgotten also the following important point: as soon as the back is removed, the lower surface of the belly is in a much better condition to vibrate the surrounding air than it was before, when it could only set into vibration the air enclosed in the body of the violin, which communicates with the surrounding air only by the small surface of the *f*-holes. This is important, as ultimately everything depends upon the degree of vibration of the air surrounding the instrument.

It seems to me highly probable that the tone of an ordinary violin with sound-post will be increased very little by the back's motion—it does not even seem improbable that there is no increase at all. If the back is put into motion by the belly, the motion of the latter will thereby

---

* Translation: "If one removes the back, the tone is a little weaker than when only the sound-post is removed. I was astonished to find that the difference was not great: there is less softness; the intensity, however, is but slightly diminished."

necessarily be diminished, as it yields a certain part of its energy to the back. It cannot be denied that the back will communicate some motion to the surrounding air, but it is very doubtful whether this will compensate for the loss of motion of the belly.

The back is evidently not meant by the violin-makers to play an important part in this respect. If they had considered it desirable that it should co-vibrate strongly, they would have made it of the same kind of wood as that of the belly, and would also have provided it with *f*-holes.

If the significance of the back in this respect is very small, yet it has also the function of limiting the volume of the enclosed air, as already remarked. We shall treat of this subject at length in the next chapter.

According to Vauchel,* much depends on the thickness of the back near the spot where the sound-post stands. This is evident, as the motion of the sound-post, and hence also that of the belly, are connected therewith.

---

* Abele, l.c., p. 165.

CHAPTER VI.

The Influence of the Enclosed Air.

WHENEVER the roof of the violin is brought into vibration, the enclosed air will be vibrated in turn.

Influence of the Co-vibrating Enclosed Air.

Now the question is, will the vibration of the enclosed air cause an appreciable increase in the intensity of sound.

This seems, *a priori*, not very probable. We have to deal here with a quantity of enclosed air, communicating with the outer air only through two small openings, the *f*-holes. The enclosed air, hence, is in a very unfavourable condition as regards the transmission of its vibrations to the outer air.

Were the enclosed air set into vibration, for instance, by some wind instrument, it would also transmit its motion to the surrounding air by means of the elastic parts of the body, principally by the belly. But as in the violin the vibration of the pent-up air is caused just by the motion of the parts of the body (chiefly again by the belly) it cannot be expected to set the belly again into vibration. Therefore, it can solely affect the surrounding air through the *f*-holes.*

---

* We shall have to revert to this afterwards.

We will first consider the opinion of different writers on this subject.

Ritter* says: "Wir gewähren an unseren Geigen aber nicht nur einen Resonanz-Boden, sondern auch einen Resonanzkasten von ganz bestimmter Form, mit zwei Schallöchern versehen."† Somewhat further: "Die Luftmasse ist also der wesentliche Faktor, durch welchen eine Geige ihre Töne erzeugt."‡

Ritter thus seems to attach great influence to the motion of the enclosed air, and separates it from the vibration of the belly.

O. Bachmann§ says that a string gives a serviceable sound only when connected with a little board capable to co-vibrate, and then continues: "Vollkommen jedoch, stark und ferntönend, wird der Klang erst dann, wenn der feste Körper, auf welchem die Saiten gespannt werden, hohl ist und einen Luftraum fast ganz ein schliesst."||

According to Savart,¶ the body of the violin serves, in the first place, to enclose a certain quantity of air for transmitting the vibration of the belly to the back. The motion thus communicated to the back is, however, very little, as Savart himself says, p. 14 of the same "Mémoire."

---

* Ritter, l.c., p. 6. See also his book, "Die Viola Alta oder Altgeige," third edition, pp. 30-3.

† Translation: "We perceive in our violins, however, not only a resonance-board (i.e., sound-board, viz., belly) but also a resonance-box of quite distinct form, provided with two sound-holes."

‡ Translation: "The air-volume is thus the essential agent whereby a violin produces its tones."

§ O. Bachmann, "Theoretisch-Praktisches Handbuch des Geigenbaues." Gottfr. Basse, Leipzig und Quedlinburg, 1835.

|| Translation: "The sound, however, becomes perfect, strong and carrying only when the firm body upon which the strings are stretched is hollow, and almost completely enclosing a volume of air."

¶ "Mémoire," l.c., p. 26.

Violin with Closed *f*-holes.

The *f*-holes of Savart's flat violin (Fig. 28) had a rectilinear shape. They serve, he says, to bring the enclosed air into communication with the outer air. If they are closed with paper, the sound is much weaker, "le son de l'instrument n'est plus reconnaissable tant il est affaibli."*

I have made this experiment with a very good old German violin, made by a disciple of Stainer. The holes were closed by pieces of velvet; instead of with glue, they were fixed on with lard, that could be easily rubbed off when the experiment was finished. The velvet was placed on the belly with the rough (under) side downward.

Although not quite so much enfeebled as Savart's expression had led me to expect, the tone was still considerably weaker than with the open *f*-holes. The quality of the sound was metallic; the D and E on the G string had a strong nasal sound.

Volume of the Enclosed Air.

Most writers on this subject are of opinion that the volume of the air in the body of the violin should have an exactly determined value. Thus, for instance, I have read† that the violin-maker, Eberle, of Rotterdam, has altered the pattern of the violin-body so as to make it easier for players with short fingers. In order to keep the same value for the enclosed air, he made the part of the violin somewhat broader in the lower bouts.

Apian-Bennewitz‡ says that the flatter violins, for instance, those of the Maggini pattern, are made larger than

---

* "Mémoire," l.c., p. 51. Translation: "The tone of the instrument can no longer be recognised, it has been so weakened."

† "Nieuwe Rotterdamsche Courant," Avondblad, A., August 24, 1912.

‡ Apian-Bennewitz, l.c., p. 81.

the more arched instruments, as those of Stainer and Klotz, "zur Erlangung des nöthigen Luftvolums" (to obtain the necessary volume of air).

Savart* has made a violin of a flat and square pattern, in which the volume of the air could be varied at will by a piston. He found that with a certain volume the violin sounded best. When the volume was too large, the lower tones were feeble and muffled, the higher tones being shrill.†

The Resonance does not Depend on the Capacity Alone.

The resonance-tone of a soundbox, however, does not depend on the capacity alone, but also on the model. This well-known fact can be demonstrated by a simple experiment:

A resonance box belonging to a tuning-fork F′ (682, 6 v. s.) by Koenig, was of the following inner dimensions:

Length, 227 mm.; breadth, 89 mm.; height, 44 mm.

In the hole intended for the stem of the fork, a brass tube was placed, connected with a rubber tube, which ended in a piece of boxwood (Fig. 52). The other side of

---

* "L'Institut," l.c., p. 70.

† At the Industrial Exhibition of Munich (1854) a violin was shown that could also be used as a trumpet! It was made by Ferdinand Hell, of Vienna. The tube of the trumpet was hidden in the body of the violin; one end of it went through the neck and ended in a mouthpiece at the top of the scroll, the other end was enlarged into a flattened oval beaker, under the tail-piece. "Weder der Trompeten-noch der Geigenton war schlecht." (Translation: "Neither the trumpet, nor the violin tone were bad.") This violin-maker does not seem to have attached great value to the air-capacity of the violin! (Abele, l.c., p. 97.)

The lute also was sometimes provided with small organ-pipes, packed in the sound-body (Mersenne, l.c., p. 91). The keys for putting the air in the tubes into motion were placed on the neck of the lute, so that a string being pressed by the finger, the valve of the corresponding tube at the same time was opened.

this wooden piece was shaped like the ear-tube of Helmholtz's resonators. The rubber tube was 40 cm. long, its internal diameter 8 mm.

The resonance-tone of the box, with the addition of the rubber tube, was found to be about E′.

Fig. 52.

Now a box was made of the following dimensions: Length, $227 \times 1.25 = 283.75$ mm., breadth, 89. mm., height, $\frac{44}{1.25} = 35.2$ mm., having thus the same air capacity as the box by Koenig.

The resonance-tone of this new box with the rubber tube was about C′.

This shows that the resonance-tone of a box does not depend only on the volume of the enclosed air, but also on the model.

Multiple Resonance.

According to Auerbach,* a "allgemeine Resonanz" (general resonance) is to be found for all "kubische und

---

* "Die Grundlagen der Musik," l.c., p. 81.

voluminöse Luftmassen" (cubic and voluminous air quantities), meaning that such volumes of air co-vibrate for almost all tones. On p. 82 of the same book he says that "der Geigenkörper" (body of the violin) strengthens every tone produced by the violin. He does not seem to differentiate between the resonance of the enclosed air and that of the belly ("Resonanzboden").

In Vol. II of Winkelmann's "Handbuch der Physik," edited by Auerbach,* the following comment is made on the resonance body of bow instruments: "Die Resonanzräume sind von solcher Grösse und Gestalt dass sie mehr oder weniger auf alle bei dem Instrument in Betracht kommenden Töne resoniren."†

The lower the sound to be strengthened by the enclosed air, the greater the resonating space should be; for this reason, it is added,‡ the bodies of the violoncello and the double-bass are made so much larger than that of the violin.

I am inclined to think that the principal reason for making these bodies so large, is to be found in the fact that for producing the strong and low tones required from the violoncello and the double-bass, the belly must have a large vibrating surface.

Apian-Bennewitz§ had a singular notion of the significance of the resonance-tones of the violin. He says that the bridge transmits the motion of the strings to the belly, "um von dieser in breiter Fläche, verstärkt durch den Eigenton der vom Geigenkörper eingeschlossenen Luftmenge, an die Aussenluft abgegeben zu werden."‖ He

* Second edition, p. 473.

† Translation: "The resonance spaces are of such a size and form that they resonate more or less to all the notes which come into consideration in connection with the instrument."

‡ "Die Grundlagen," l.c., p. 82.

§ Apian-Bennewitz, l.c., p. 131.

‖ Translation: "To be transmitted by this to the outer air from a broad surface, strengthened by the resonance-tone of the air enclosed in the body of the violin."

seems thus to suppose that every violin tone is accompanied and strengthened by the resonance-tone of the enclosed air.

This is naturally wrong. If, for instance, F′ is played, and the resonance-tone C′ should make itself heard, it would be heard together with the F′, yet that can scarcely be called a reinforcement of the F′. If this really happened, playing the violin would produce about the same effect as if one held down one particular key permanently in organ playing.

Radau* says of the quality of the violin-tones: "Dans le violon leur timbre (le timbre des cordes à boyau) est légèrement modifié par la résonance de la caisse, dont le son propre est l'ut"† (C′).

Methods of Observing the Resonance-tones.

Savart‡ has determined the resonance-tones of the violin in the following way: he took a brass tube of conical form, the wider end of which was flattened, so that its opening formed a slit. Through this tube he blew against the sides of the *f*-holes; in the case of a Stradivarius violin he found in this manner the resonance-tone to be C′ (512 v.s.).§ The experiment can also be made without this tube, by simply blowing against one of the sides of the *f*-holes.

Savart found the resonance-tone of the enclosed air to be the same as that of the belly and the back. Starting from this observation, he also determined the tone of the

* Radau, "L'Acoustique ou les Phénomènes du Son." Hachette, 1867, p. 257.

† Translation: "In the violin their timbre (the timbre of gut strings) is slightly modified by the resonance of the body, of which the resonance-tone is C."

‡ "L'Institut," l.c., p. 69.

§ "L'Institut," l.c., p. 69.

enclosed air by fastening a glass tube or rod perpendicularly to the belly or the back, and causing this to swing longitudinally by friction.*

Helmholtz† found two resonance-tones for the violin, in the following manner. The violin was held with its back against the ear while a scale was played on the piano. The tone corresponding or lying near to the resonance-tones of the enclosed air were then heard, greatly intensified. For a violin of Bausch he found C′, C′ sharp and A′, A′ sharp; the latter two, however, much weaker than C′ and C′ sharp. For a very ordinary violin, I found in this manner C′ sharp and A′ sharp.

I have observed these tones much more distinctly in the following manner. The strings, the bridge, the tail-piece, with the loop of gut attached, and the button, were removed from the violin.‡ It was then fastened by wooden clamps to a board a b (Fig. 53), movable between

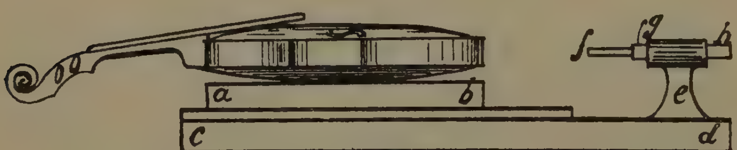


FIG. 53.

two ledges on the board c d. At the end of c d a small support or standard was placed in which a copper tube, f g h, was clamped. The part f g of this tube was 28 mm. long; its internal and external diameters were 3.6 and 4 mm. respectively. The length of g h was 45 mm.; its internal and external diameters were 8 and 9.5 mm respec-

---

* "L'Institut," l.c., p. 69. See also Chapter III, p. 60, foot-note.

† Helmholtz, l.c., p. 146.

‡ The violin used for this experiment was a very ordinary violin.

tively. Round the end of g d was a rubber tube, the other end of which divided into two rubber tubes, each of them ending in a little ebonite tube, Fig. 54, to place into the ear, such as was formerly used in connection with the gramophone. Inside the two rubber tubes were springs of hard copper wire, which pressed the end-pieces into the ears so that they could not fall out, thus leaving both hands free. The hole in the violin, out of which the button was taken, had a diameter of about 8 mm.; the copper tube being located so that it was placed exactly in the middle of the hole when the slide was pushed to the right side.

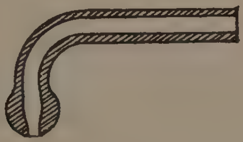


FIG. 54.

When the slide was drawn to the right side as far as possible, the edge of the belly was still clear of the rim g of the tube, so that there was no contact between the tube and the violin. To control the proper position of the ear-tubes, a watch was placed on the belly; as long as its ticking was distinctly heard in both ears, everything was in order.

The following experiments have been made with this apparatus, the metal tube inside the body of the violin:

1. A piece of hard, stiff paper was folded or crumpled near to one of the *f*-holes, but without touching the belly. The tone was distinctly heard in the ear-tubes, and, when listening attentively, also A′ sharp, but this was much weaker. Not every kind of paper, however, gave the A′ sharp, and the same piece of paper sometimes pro-

duced it and sometimes did not; the folding of the paper was not done by the experimenter, but by another person.

2. A scale was then played on another violin. The C′ sharp and D′ were heard much louder in the ear-tubes than the other notes; the same was the case with the A′ sharp and B′, although in a much lesser degree. With pizzicato notes instead of those played with a bow the result was the same and equally distinct.

3. Again, a scale was played on the violin very slowly and with long strokes of the bow. At the beginning of the stroke the slide was pushed entirely to the left, the tone was thus received from the outside air. When the assistant saw that the bow had reached the middle, the slide was pushed to the right, so that the same tone was now heard from the inside of the violin.

Of course, C′ sharp and D′, and in a lesser degree A′ sharp and B′, were now heard much louder than before. But it appeared that all violin-tones were heard somewhat louder when taken from the inside of the violin than when taken from the surrounding air, this difference being very small, however, for the non-resonant tones.*

As an organ produces a long-sustained tone of constant intensity much more easily than a violin, I made the same experiment with the first-named instrument. The results were the same as when using the violin. But for several tones a difference of timbre was observed, according as the sound was taken from the surrounding air or from the violin-case, and this made it sometimes difficult to judge of the small difference of intensity. Thus, for instance, the difference of timbre was very distinct for the A, it even seemed as if for this tone the sound taken from the surrounding air was somewhat stronger than when taken from the enclosed air. That the A showed this difference in such a marked degree lies evidently in the fact that its

* For shortness sake, I will call all violin-tones except C′ sharp, D′, A′ sharp and B′, non-resonant tones, although this name perhaps is not quite correct.

first harmonic, A′, corresponds approximately to one of the resonance-tones of the enclosed air.*

I made these experiments with the sliding violin because it is easier to hear a variation in the intensity of one particular tone than the difference between the intensity of two notes of different pitch, as attempted in experiment No. 2.

4. A piece of music was played on a violin and listened to through the rubber tubing, with the metal tube inside the body of the test-instrument. Through the strong reinforcement of the resonance-tones the greater part of the music became unenjoyable as soon as notes near to the resonance-tones of the enclosed air were played. This was even more noticeable when a piano was used instead of the violin. The sounds which then came from the inside of that instrument were musically absolutely useless.

From experiment No. 3 it follows that the air inside our test-violin vibrates stronger for all violin-tones than the outer air, although the difference is very small.

For the reinforcement perceived in our test instrument for *all* violin-tones, three explanations might be given:

1. It might be possible that we have to deal with the resonance of the belly for the notes C′ sharp, D′, A′ sharp and B′, that therefore the belly sets the outer air into much stronger vibration for these notes than for all the other

* The possibility of resonance between unequal periods of vibration (the driver and the driven being of different pitch) was already known to van Nierop (l.c., p. 18). He mentions that a clock when struck, or a string vibrated by a bow, will cause another clock or string in close vicinity to co-vibrate, not only when they have equal pitch, but also when the inducted clock or string vibrates twice or four times as quickly as the inducing one. He says that this is also the case when the ratio of the numbers of vibration is as 2 : 3 or 3 : 4. This, however, cannot be true, 3 not being a harmonic to the prime 2, nor 4 being a harmonic to the prime 3. He seems to have mistaken the octave and the duodecimo of the driver for the prime. With bells this mistake is pardonable, as with them the overtones often are of greater intensity than the prime.

notes of the violin. Then the motion of the enclosed air caused by the motion of the belly would be stronger for C′ sharp, D′, A′ sharp and B′, than for the remaining violin-tones, and hence would produce a louder sound in our hearing-tubes, which is in accordance with the observation.

But if this were so, the belly would not be passive, and it would follow from this that our test-violin, being provided with strings and played upon, the resonance-tones would appear so much stronger than the other tones (just as heard in our test-instrument), that the violin would be quite useless from a musical point of view. As this is not the case, the explanation cannot be true.

2. It might be that the enclosed air acted as a resonator for all violin-tones, strongest for the resonance-tones, and very feebly for the other tones; it does not seem illogical to suppose that the various hollow spaces of the peculiarly fashioned body of the violin resound individually, to some extent, to particular tones corresponding to their form.

3. Lastly, it might be that the reinforcement of the tones, C′ sharp, D′, A′ sharp and B′, as observed with the tubes, was caused by the resonance of the enclosed air, aided by the co-vibrating of the belly, and that the small reinforcement of the non-resounding notes, being about the same for all of them, may be ascribed to the belly's co-vibration with the outer air, transmitting part of its motion to the enclosed air. This last explanation seems to me the most probable. For testing it, a violin of the ordinary model should be made of very thick wood, so that practically the belly would not be set into motion by the vibrations of the outer air. If such a violin were fixed on the apparatus, Fig. 53, probably only the notes, C′ sharp, D′, A′ sharp and B′, would be heard reinforced when the brass tube were inserted into the violin body.

When experimenting with the apparatus, Fig. 53, one wonders that the reasonance-tones are not a greater nuisance when the violin is played than they really are. For if those tones were heard much louder than the non-

resounding tones, as heard from the inside of the violin, the violin would be a worthless instrument.

We saw what happens with our test-instrument when hit by vibrations caused by another instrument. We will now consider what happens when it is provided with strings and played upon.

The energy of the motion of the enclosed air may be considered as the sum of two terms or parts. The first is that part of the energy caused by the vibration of the belly. This cannot increase the belly's motion, as shown on page 89.

The second part is the quantity of motion communicated to the enclosed air by the vibration of the air outside, caused by the strings and propagated to the enclosed air through the *f*-holes. This term may cause a small augmentation of the motion of the roof.

But if we remember that the belly receives its vibrations from the hammering movement of the left foot of the bridge, it is evident that this reinforcement of the belly's motion by the enclosed air may be neglected.

We may therefore conclude that, practically, the enclosed air will not communicate its vibrations to the belly. Only by means of the *f*-holes it will be able to transmit a small part of its vibrations to the outer air, and only by this means a small augmentation of the intensity of some tones will appear, when the violin is played on, by the resonance of the enclosed air.

That the enclosed air is really able to reinforce the vibrations of the surrounding air is proved by the following well known experiment: If a tuning-fork is fixed on a resonance box, as made by König, the air in the box will vibrate strongly as soon as a bow is drawn across the fork. A strong sound will then be heard in the proximity of the box, which proves that the air in it transmits its vibrations to the outer air. Now just the same happens with our violin, but here the conditions are not so favourable, as the communication of the enclosed with the outer air can only

take place through two relatively small openings (the *f*-holes), whereas the mouth of König's resonance box is very large.

When a violin is played upon, the reinforcement of the tones of equal pitch with the resonant tones is of so little account that it has no disturbing influence. That it exists, however, there is no doubt; so, for instance, on a good viola in my possession the tone B* is perceptibly stronger (responds more quickly) than the other tones. But probably many violinists who have never heard of resonance-tones will not have remarked this difference of intensity.

That this reinforcement of the resonance-tones is so little disturbing is solely due, so it seems to me, to the small surface of the *f*-holes. We have already alluded to this on page 89.

The difference of intensity of the resonant and the non-resonant tones, as heard by means of the apparatus of Fig. 53, is very great. As so very little of this difference is perceived when the violin is played, I conclude from this *that the whole motion of the enclosed air*, for the non-resonant as well as for the resonant tones, *has very little influence on the sound of the violin*, and that the intensity and quality of the sound is almost exclusively due to the motion of the belly.

Yet the weakening of the sound by stopping the *f*-holes is not inconsiderable as we have seen. I suppose the pieces of velvet used for closing the *f*-holes hindered by their weight the motion of that part of the belly next to those holes. When using a piece of thin paper or a membrane instead of the velvet, such covering will co-vibrate and take over the function of the *f*-holes. Barton† has thus registered the vibrations of the air in one of the *f*-holes by closing it by a membrane. I have myself experi-

* For the viola the resonance-tone is B flat—B.

† "Phil. Mag.," June, 1912, p. 885.

mented with a piece of thin paper; a secondary sound, however, made itself heard in that case, caused by the vibration of the paper.

As the tones, C′ sharp, D′, A′ sharp and B′, are reinforced by the resonance of the enclosed air, they will be—theoretically—somewhat mellower than the other tones of the violin, as this reinforcement does not affect the overtones; the lower octave of A′ sharp and that of B′, on the contrary, will—theoretically—be shriller, as in their case the first harmonic is reinforced. But as but little of this reinforcement is heard except inside of the violin, this change of timbre does not become apparent.

The resonance-tone of the viola is B flat—B, therefore only one tone lower than that of the violin. As the strings are tuned a fifth lower, the resonance-tone of the viola is found on the third string, whereas for the violin the stronger resonance-tone is on the fourth.

Difference of Timbre between Violin and Viola.

Helmholtz* supposes some connection to exist between the difference of timbre of the violin and the viola and the respective difference in the position of the resounding tones. It seems to me very probable that the larger dimensions of the belly of the viola must also be taken into account.

Auerbach† asserts that for the viola the dimensions are too small in comparison with the pitch of the strings. This agrees with Helmholtz's opinion. If, however, the viola was made larger, so that its resonance-tone became, say, a fourth lower in the scale, then the most favoured note would be the fourth string, just as in the case of the violin.

For investigating the influence of the resonant tone of

---

* Helmholtz, l.c., p. 147.

† "Die Grundlagen," l.c., p. 105.

the enclosed air upon the sound of the violin the two following methods might be used:

Violin with Filled Body.

(1) The body of the violin might be partially filled up, but in such a manner that the belly, the back and the sound-post were left free; for instance, by fastening wooden strips or blocks to the inner side of the ribs. The motion which the back receives from the vibration of the ribs would thereby be partially lost, but that would be of little consequence.

Open Violin.

(2) A violin might be made without a back; instead of a back two small wooden laths fixed crosswise, one of these carrying the sound-post. The small inequality in the intensity of the violin tones, in so far as it is caused by the resonance of the enclosed air will then disappear. Possibly two or more large holes in the back would also serve the purpose.

As has been said on page 86, Savart has experimented with one of his flat violins without back; he found the sound to be not much diminished as to intensity, but to be somewhat less mellow.

When the difference of position of the resonance-tone is sufficient partially or wholly to cause the difference of timbre between viola and violin, as Helmholtz supposes, then will the entire absence of that tone, as in the case of the open instruments, undoubtedly cause a great change in the timbre. Whether there will then still be a difference of timbre between the open violin and the open viola can only be shown by experiment.

In such an open violin it would be easy to reach the sound-post; perhaps it would be possible to exactly regu-

late its length after it has been put into its proper place. This would be of great advantage.*

Quantitative Comparison between the Common and the Open Violin.

For a common violin three agents contribute to set the surrounding air into vibration:

(a) The surface of the belly.

(b) The air in the *f*-holes.

(c) The outside of the back.†

For the open violin we should have two agents:

(d) The surface of the belly

(e) The inner side of the belly.

By leaving out the back we lose the agents *(b)* and *(c)*, but the outer air would then receive stronger vibrations from the inner side of the belly than those produced by the outside of the back, as in the case of the common violin. Hence I suppose that the loss of the agents *(b)* and *(c)* will be fully counterbalanced by the gain of the agent *(e)*.

It should also be considered that the belly of the open violin is not required to put into vibration a second board (the back), not so well adapted for the purpose on account of its form (missing the *f*-holes), and the kind of wood of which it is made, so that each of the agents *(d)* and *(e)* will be greater than *(a)*.

When all this is taken into consideration it appears to me probable that the sound of the violin without back will be stronger than that of the common violin, provided the belly makes the same motion as it did before the removal of the back.

---

* See Chapter IV, p. 73.

† The ribs vibrate tangentially, i.e., perpendicularly to the surface of the belly and the back. They cannot, therefore, transmit vibrations of any consequence to the outer air.

Violin with Perforated Back.

As a preliminary experiment I made five holes in the back of the instrument used for the experiment of Fig. 53, this being the nearest approach to an entirely open violin, as may be seen from Fig. 55. The diameter of the three larger holes was 75 mm., that of the other two 48 mm. The violin was then placed on the apparatus, Fig. 53, with the back downwards, so that the distance between the back and the upper side of the board *ab* was 4 cm., thus leaving the holes free.

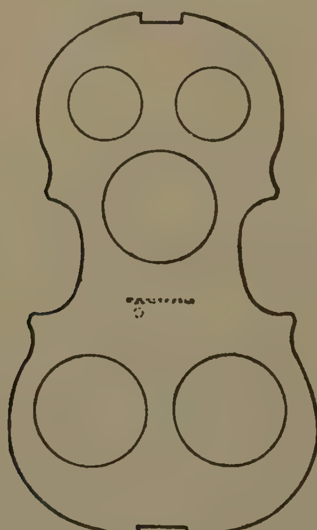


FIG. 55.

With this apparatus the following experiments were made:

(1) Blowing against the side of one of the *f*-holes. No resonant tone was heard.

(2) Folding and crumpling a piece of stiff paper near

one of the *f*-holes. The tones D′ and B′ were heard, but very feebly, much more feebly than the C′ sharp and A′ sharp, heard formerly in this way, when the back of the violin was still whole.

(3) A scale from G to G′ was played on a pianoforte. The D′ was heard a little stronger than the other tones. Scale from A to A′: all tones were heard with the same intensity, B′ not stronger than the other notes.

(4) A scale was heard, firstly with the brass tube inserted into the violin and secondly with the violin turned sideways. The sound heard in the former case, from the inside of the violin, was a little stronger for all tones than when picked up by the tube from the air outside.

(5) A piece of music was played on the pianoforte. The B′ was heard somewhat intensified. The music was somewhat rattling (clanking) or shrill, but very different from what was formerly heard when using the violin with a whole back, when the resonant tones came out, as it were, tempestuously.

(6) The violin was taken off the sliding apparatus and the belly applied to the ear. A scale now being played on the pianoforte all tones were perceived with the same intensity.

Compared with that of the violin with a whole back, the resonance was of no account.

When the violin was mounted with strings and played on, the following was heard:

The G and the D strings were both very bad, the sound of the G was sharp and nasal, and still worse than that of the D. The latter, however, was already very bad before the back was perforated. The A and the E strings, as to timbre and intensity, had not changed perceptibly.

For these experiments as well as for those with the apparatus of Fig 53, the violin was provided with a sound-post.

It appears obvious to attribute this change in the sound of the violin by the perforations in the back, to the almost entire absence of resonance-tones. The fact that the tones on the G string above the G′ had not changed their timbre

points also in this direction, as the absence of the resonance-tone, C′ sharp, can have no influence upon those tones.

Against this however stands the fact that the note G (the open G string) of the perforated violin was also very bad. As the resonance of the enclosed air for this tone was already insignificant when the violin was still provided with its whole back, the bad quality of this tone G cannot be attributed to the absence of that resonance.

By putting a mute on the violin, the sound, especially that of the two lower strings, appeared to be much improved. In accordance with the already mentioned experiments of de Haas and the writer, one might conclude from this that the fundamental tones of the lower strings were too weak in proportion to the overtones through absence of the air-resonance, and that this proportion was improved by the effect of the mute. If one considers, however, that all bad violins, when provided with a mute, sound much better than without, and that this is also the case with good instruments when played by unskilled violinists, then this explanation appears somewhat doubtful. I rather think that in the case of a bad violin or a good one played badly, disturbing noises will appear, which are weakened by the action of the mute and so become less perceptible, and that this is also the case with our perforated violin.

The change in the sound of the G and D strings I believe to be caused principally by the part of the perforated back on which the sound-post rests being more elastic than the whole back, and the motion of the belly consequently not being checked so much by the sound-post. The sound of the perforated violin shows also a great resemblance to that of the same instrument with a whole back and without the sound-post (page 80). In both cases the sound of the two lower strings bore more resemblance to that of a wind instrument than that of a violin. The D string of the perforated violin, when bowed softly, gave a very good imitation of a clarinet.

If the motion of the belly is less checked by the sound-post, the division of the belly will not be the same as with

an ordinary violin. I suppose that by strengthening the middle part of the perforated back and altering the position and the dimensions of the sound-post, the belly of the perforated violin could be made to behave exactly as that of a violin with a whole back.

I may add that the sound of the same instrument with a whole back and closed *f*-holes was much weaker than it was with an open back and open *f*-holes.

The change in the sound of the G and the D strings caused by the perforation of the back, appeared to be much greater than the change of timbre caused by closing the *f*-holes when experimenting with the good old violin, as described on page 91. It may be concluded from this, as it seems to me, that if there exists a connection between the bad timbre of the lower strings of our perforated violin and the absence of air-resonance, it can only be a very slight one, as otherwise the change in the quality of sound, caused by the closing of the *f*-holes, would be much greater. I must add, however, that the great difference in quality between the two violins used for these experiments made the comparison rather difficult. One was a very good old instrument, the other a common factory violin, as said before.

I cannot deny that these experiments with the perforated violin are not decisive; in other words they do not prove that the influence of the resonance of the enclosed air on the formation of the tone of the violin is so small as I hoped to be able to deduce from the experiments described on page 104. But I mention them principally in the hope of inducing other investigators to continue in this direction.

At all events it follows from these experiments that the opinions of Ritter (page 90) that the sound of a violin depends principally on the vibration of the enclosed air, is not right.

If it were possible to cause the belly of a violin, from which the back has been wholly removed, to make exactly the same motion as that made by the belly of the same violin when still provided with a back, there would be

every reason to suppose that this open violin would sound stronger than before the removal of the back,* and as the resonance of the enclosed air would then be wholly eliminated, the sound of the open violin would also be more equal.

To arrive at this the crossbar for carrying the sound-post would probably have to be somewhat elastic, in the same way as the back. At the same time the ribs would probably have to be made stronger, as otherwise the outer rim of the belly would vibrate more strongly than in the case of an ordinary violin.

Whether this can be achieved in practice, only experimental research undertaken by a skilful violin maker and preferably with a very good instrument, can show.†

I must add here that I did not make these experiments in the hope of improving our bow instruments, but only to arrive at a clear understanding of the nature and importance of the air resonance.‡

---

* See pp. 105-6.

† According to Heron-Allen (l.c., p. 108), J. J. Hawkins took out a patent, as early as 1800, for a violin without back or ribs, but only a strong rib running beneath the belly, on which was placed the sound-post, which was pressed against the belly by means of a spring. "We are told that the mere loudness of a fiddle was but little impaired by this ruinous proceeding, though even this is a matter of considerable doubt; at any rate, it is acknowledged that the quality of the tone was utterly destroyed." That the tone quality was different from that of a common violin was to be expected, as the rim of the belly in this case, owing to the absence of ribs, took part in the vibration, which, as Barton found, is not the case with a common violin.

‡ Barton ("Textbook," l.c., p. 407) says: "He (the physicist) can but seldom pose as a critic of what has been accomplished, or even as a suggester of lines for further advance; so far, in this department, has practice outstripped theory." What is here said of musical instruments generally is in the first place applicable to bow-instruments.

CHAPTER VII.

THE *f*-HOLES.

AS told already in Chapter III (page 41) the *f*-holes serve to make the middle part of the belly sufficiently flexible.

Savart* says on this point that the sound of the violin becomes much weaker when the *f*-holes are placed in the back instead of in the belly. If they served only to bring the enclosed air into communication with the outer air, it would not make any difference whether they were located in the belly or in the back.

Shape of the *f*-Holes.

Practice has shown the form of the letter *f* to be the best. By changing this the degree of flexibility of the belly evidently will be changed too and so will the division of the belly, caused by its co-vibration with the strings.

Place for the *f*-Holes.

Efforts have repeatedly been made to give the *f*-holes not only a different form but also a different position. Thus, for instance, a circular hole in the centre of the belly

---

* "Mémoire," l.c., p. 51.

under the fingerboard has been tried, as well as holes in the ribs, but the usual place always proved to be the best.*

That the *f*-holes serve to bring the enclosed air into communication with the outer air has been mentioned already in Chapter VI; also that the intensity of the sound is considerably reduced by closing them (page 91).

* Otto, l.c., p. 18.

CHAPTER VIII.

THE BASS-BAR.

THE bass-bar is an oblong wooden rib glued to the left side of the inner surface of the belly.* In Fig. 56 the belly is seen from below, g f showing the bass-bar. Fig. 57 is a longitudinal section of the belly through the middle of the bass-bar, which is again indicated by g f.

Function of the Bar.

According to Maugin and Maigne† the bar serves to strengthen the belly, so as to enable it to support the pressure of the strings, and also to give the two lower strings, "la gravité du son" (the *weight* of tone).

Apian-Bennewitz‡ says that the bass-bar is now made longer than in the days of Stradivarius because the pitch is higher now. By this elongation the "Eigenton der Decke und des ganzen Violinkörpers" (the resonance-tone of the belly and the whole violin-body), also is

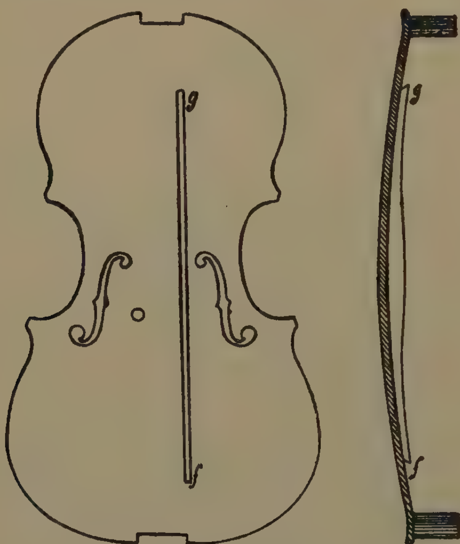
* Factory violins often have the belly and the bar made in one piece.

† Luthier, l.c., p. 65.

‡ Apian-Bennewitz, l.c., p. 97.

raised, and the belly will be strengthened to resist the pressure of the strings, which at the present time is far greater than at the time of Stradivarius.

According to Vidal,* the bass-bar not only serves to strengthen the belly, but also to transmit the vibrations, caused by the left foot of the bridge, over the whole length of the instrument. Hence the vibrating surface becomes larger and the sound stronger.



Figs. 56 and 57.

Otto† says that the bass-bar serves, "um das Gleichgewicht der Deckenschwingungen gegen die stärkeren Schwingungen der tieferen Saiten herzustellen" (to restore the balance between the vibrations of the belly and

* Vidal, l.c., T. I, p. 110.

† Otto, l.c., p. 20.

the stronger vibrations of the lower strings). He says also that the bass-bar carries and steadies the belly, but that its principal function is to spread the vibrations over a larger surface. Much the same is said by Wettengel.

Von Gontershausen* tells us: "Der Balken hat den Zweck zu erfüllen dem Ganzen mehr Widerstandsfähigkeit gegen die von den Saiten veranlasste Spannung zu geben. Zugleich ist er der Vermittler, dass die Schwingungen des Steges sich dem Resonanz in der ganzen Länge der Decke einprägen, und nicht in eine Anzahl kleiner Felder getheilt werden, die unregelmässig schwingen."†

According to Fétis,‡ the bass-bar in the greater part of old instruments has afterwards been replaced by a stronger one, as formerly the pressure on the strings was smaller than it is at present, owing to three different causes: (1) the strings used formerly were thinner; (2) the bridge was lower; (3) the pitch was lower. Fétis says that Tartini found in 1734: "Que la charge des quatre cordes sur l'instrument égalait 63 livres" (that the pressure of the four strings upon the instrument equalled sixty-three pounds), being about 31.5 kgr. I suppose by "charge" Fétis means the pressure on the bridge, as he adds that one should consider that Tartini's strings were thinner than is usual now, and *that the bridge was then lower than those now in use.* Now, if by "charge" were meant the *tension* of the strings, he should not have mentioned the height of the bridge, as that has nothing to do with the tension.

But the pressure of the strings cannot then have been

---

* H. Welcker von Gontershausen, l.c., p. 63.

† Translation: "The object of the bass-bar is to give more power of resistance to the whole against the tension of the strings. At the same time it is the mediator, by means of which the vibrations of the bridge may be spread throughout the whole length of the belly (lit., 'may be impressed in the resonance' throughout, etc.), and not be divided into a number of small sections, which vibrate irregularly."

‡ Fétis, l.c., T. I, p. 92.

31.5 kgr., as now, with strings of medium thickness, it is only 10 kgr. (Chapter I, p. 10). If by "charge" is meant tension, Tartini's statement cannot be said to prove that the tension at that time was smaller than it is now, as we found for it, taking an average set of strings and the usual pitch, 24431 gr. (Chapter I, p. 10), thus being still smaller than the number given by Tartini. There is evidently a mistake in this.

CHAPTER IX.

THE INFLUENCE OF AGE ON THE VIOLIN.

Maturing of the Violin by "Playing-in."

MOST violinists and violin-makers are of opinion that a newly and well-made bow instrument improves when played upon for a considerable time, preferably by a skilful violinist, and that such a "played-in" instrument relapses again when it is left unused for a considerable time.

This opinion, it seems to me, is not unassailable; two arguments can be brought against it.

1. Adaptation of the Player to a New Instrument.

It might be imagined that a player, using a new violin, would gradually learn, though wholly unconsciously, to overcome the peculiarities or weaknesses of his instrument, and that thus the seeming improvement of his violin would be due solely to his manner of treating it.

Something similar happens when a player, who is used to his own instrument, gets another old and much-used

---

* For want of an equivalent term we give the literal translation of the Dutch "Inspelen" (German, "einspielen") for brevity's sake, which means bringing an instrument into good condition, so that it responds easily, by playing upon it a great deal.

violin. Even then it will be some time before he is as familiar with it as with his own instrument. Of course, he will then attribute this to his manner of playing having adapted itself to the instrument, and not to the instrument having got better by having been played on. Just the same is the case with a new violin, where also the adaptation of the performer plays a large, perhaps the only, rôle.

Superficially one might think this question could be easily solved in the following manner: when A has bought a new violin, he asks B to try it, and takes note of his opinion. Then A will play on the instrument, say, for a year, and after that time ask B again to play on it. In this way one would find out any alteration in the instrument which it might have undergone during that time, as the adaptation of A to his instrument naturally would not influence the judgment of B.

2. Difficulty of Comparing Two Violins.

But if one considers of how little value the judgment about the relative merit of two violins often is, even when heard alternately in immediate succession, and judged in good faith by skilful musicians, no great value can be attached to two tests of the same instrument with a long interval of, say, a year between them.

We will give some examples of this difficulty.

Vidal* says the following on this head: "Un des phénomènes les plus surprenants, peut-être, de l'histoire des instruments à archet fut l'accueil favorable accordé a ces innovations, au fur et à mesure qu'elles se produisaient. Les Sociétés Savantes auxquelles elles étaient soumises ne tarissaient pas d'éloges. . . . . "†

---

* Vidal, l.c., T. I, p. 68.

† Translation: "One of the most astonishing phenomena, perhaps, in the history of bowed instruments, was the favourable reception accorded to these innovations, as they showed themselves.

He quotes several examples, f.i., of violins of Savart and of Chanot, compared to an excellent Stradivarius, and judged by all the members of the committee to be better, or as good as the latter. Yet all members of this committee were "des hommes assurément compétents et dont l'oreille devait avoir la finesse désirable pour bien juger."*

Another instance: the trapezoid-formed violin of Savart has been judged favourably by a committee of musicians, whereof Cherubini was a member†: "L'opinion unanime a été que le nouveau violon pouvait passer pour un violon excellent" (the unanimous opinion was that the new violin could pass for an excellent violin).

Somewhat farther: "L'ouvrier le plus ordinaire fera encore ainsi à coup sur un très-bon violon pour un prix extrêment modique, parceque les qualités principales, la beauté et l'égalité des sons, dépendent uniquement des principes théoriques sur lesquelles l'instrument est établi."‡

The learned societies to whom they were submitted were unstinting in their praise. . . . . "

The exterior of a violin is often of much influence in judging its value. Reade expresses this by saying "Violins are (often) heard by the eye." ("Readiana," by Charles Reade, Tauchnitz, 1882, p. 99.) In the same book (p. 63) a rather good definition of a good, or at least, a musical, violinist is given by a Scotsman: 'A mon is a player when he can gar himse' greet wi' his fiddle" (make himself weep).

* Translation: "Men undoubtedly competent, and who should possess the desirable acuteness of ear to judge well."

† "Ann. de Chim. et de Phys.," T. XII, 1819, p. 225.

‡ Translation: "The most ordinary workman will thus be able to produce with absolute certainty a very good violin at an extremely moderate price, because the principal qualities, beauty and equality of tone, depend entirely upon the theoretical principles upon which the instrument is constructed."

Quite the reverse is the opinion of A. Bachmann ("Le Violon," Paris, 1906, p. 102) on this violin. He says of it, "impratique à jouer et détestable comme sonorité." I cannot imagine the instrument of which Cherubini gave so favourable an opinion to have

Notwithstanding this, nothing has afterwards been heard of these instruments. On p. 254 of the report the writer says one must, to some extent, become used to this violin, "sans cette habitude . . . . on n'obtient qu'un son sourd et peu agréable"* (without that . . . . the tone produced will be dull and not very pleasing).

If one accepts the arguments named, sub. 1 and 2, as granted (the adaptation of the player to a new instrument and the difficulty of forming a reliable judgment) it is clear that an improvement of the violin by being played upon becomes somewhat doubtful.

That the best violins are old ones does not prove anything, as nobody knows whether they were not equally good when new.

If, on the contrary, however, it be true that a new violin does improve by being played upon, then the explanation must be found in the fact that a new belly cannot divide itself into the necessary parts required for producing the

---

been quite so bad as that. I rather suspect Bachmann had a very bad sample of the trapezoid-formed violin.

Heron-Allen, l.c., p. 119, says of Savart's violin : "There is no doubt that a violin properly constructed on the Savart model, though falling far short of a first-rate fiddle of the ordinary kind, would be very much superior to the common Mirecourt wholesale production, besides being very much easier for an amateur to construct."

* In the periodical, "Die Musik," 2es Maiheft, 1912, under the heading, "Nachrichten und Anzeigen," an invention is mentioned by Dr. Franz Tomastik affecting the construction of bow instruments. By "einige für das Auge kaum wahrnehmbaren Veränderungen" (some alterations scarcely noticeable to the eye), as the paper says, he did attain that the sound had thrice the intensity of that of an ordinary violin; the sound, moreover, was "unendlich veredelt" (infinitely ennobled). In the autumn of 1912 a concert was to have been given in Vienna with these instruments. The editor of the periodical was kind enough to tell me, on January 25, 1915, in answer to my question, that he had heard nothing more of these instruments or the concert.

higher tones and the harmonics of the lower tones, and that the amplitude of the vibration is insufficient.*

If this be true, then it seems to me very probable that a violin can only be made "old" by playing it in the ordinary way, and that a good player will be wanted, as otherwise a wrong division of the roof will be brought about. This can never be accomplished by setting the violin into vibration by mechanical means.

Just as the use of "playing-in" seems to me open to doubt, so it will be difficult to prove that a good violin will relapse, or get out of condition, by not being used for a considerable time.

We will now consider what has been said on this subject by different authors.

Helmholtz† says that the excellence of old instruments is probably due to their age, and especially to the fact that they have been played upon for a long time, "welche beide auf die Elasticität des Holzes nur günstig einwirken können" (both of which facts can only have a favourable influence upon the elasticity of the wood).

Auerbach‡ says: "Es ist nämlich im Wesen der Schwingungen begründet dass die Körper, die sie ausführen, sich ihnen mit der Zeit immer besser anpassen. (Eine Geige leidet durch brach liegen stärker als unter Benützung)."§ It seems to me that this is stating a fact, but not giving an explanation.

According to Otto,‖ a played-in violin will deteriorate by being out of use during a long period. The advantage of playing-in he tries to explain by saying: "In dem

* The varnish also must become hard first, but this will probably not require much time.

† "Tonempfindungen," l.c., p. 145.

‡ "Die Grundlagen," l.c., p. 103.

§ Translation: "It is in the nature of vibrations that bodies which respond to them (lit., execute them) will accommodate themselves more and more to them in the course of time."

‖ Otto, l.c., p. 62.

die Schwingungen dem Instrument zur Gewohnheit werden" (the vibrations becoming a habit of the instrument).*

Wettengel† says that inferior factory violins having been played upon over a considerable period by village musicians, may often, at small cost, be made into "werthvolle Instrumente" (valuable instruments). It does not seem to require a good violinist for playing-in.

Stoeving‡ believes a good player to be necessary for this purpose, but is so little sure of it that he dares not state it as a fact: "But there is one thing (I would not call it a fact) interesting in connection with playing on a violin. It is that a good player's playing will do what a bad player's cannot do; in other words, an instrument may or may not improve under certain conditions with age—viz., playing . . . . it has been my experience (and I have heard it corroborated) that a tolerably good instrument will deteriorate in a comparatively short time under the clumsy, harsh, unsympathetic treatment (*tone*-production) of a pupil, and from this one may infer that the opposite is the case under opposite circumstances."

Stoeving expresses himself very prudently, and dares not call the amelioration a fact, as shown by the above.

Fétis§ asserts that the violins of Stradivarius were as good as they are now from the very beginning, that therefore they did not improve by being used. He draws this conclusion from having seen at Paris an excellent violin

---

* This reminds me of a story told by Berlioz. On the occasion of an examination of a school of music, the G minor Concerto by Mendelssohn had to be played thirty-one times on the same piano. When the piece had been played twenty-eight times, the instrument played the whole of the concerto, without the twenty-ninth pupil touching the keys! In this case also it "war dem Instrument zur Gewohnheit geworden" (had become a habit of the instrument). (Hector Berlioz, "Gesammelte Schrifte;" German translation by Richard Pohl, Vol. II, p. 298.)

† Wettengel, l.c., p. 101.

‡ Paul Stoeving, "The Story of the Violin." London, the Walter Scott Publishing Co., Ltd., 1904, p. 150.

§ Fétis, l.c., T. I, p. 77.

by Stradivarius, looking like brand-new, and which, as he believes, had never been played upon. But it is not at all impossible that this instrument has been used and handled so carefully as to show no damage at all, as Wettengel justly remarks. "Uebrigens," says Wettengel, "steht dieser Pariser Stradivarius nicht so einzig da, was die Konzervirung betrifft" (after all, this Strad does not stand alone as far as conservation goes).

A. Bachmann* asserts that violins made by Leon Fischesser do not require to be played-in at all.

Stoeving (l.c., p. 122) even mentions the possibility of a violin becoming worse by being played on too much: "I do not know whether it is an actual fact, but it is affirmed that some of the best Stradivarius violins have already been played out, worked to death, left a mere wreck of their former self as far as tone is concerned. I can almost believe it, for I know from experience that a violin when played on for hours at a stretch, will get tired, and the voice husky like an overworked singer; only rest will restore the tone to its usual brightness and responsiveness. In the plush-lined, scented box, under lock and key, at the rich collector's house, these old gems take their holidays. Let us be glad for the sake of future generations, and thankful to the rich for his selfish propensity."

Is it not possible that Mr. Stoeving mistook his own tiredness for that of the violin?

On p. 149 he says: "It seems reasonable enough to suppose that age will improve a fiddle as it does wine; but absolutely sure—no, we are not. Nor are we even sure that *merely* playing on a violin will so very materially (as is usually taken for granted) change for the better its inherent qualities."

Koch (l.c., p. 65) calls the improvement of a violin by frequent use a fable; he says the same of the asserted great influence of the varnish.†

---

* A. Bachmann, l.c., p. 103.

† According to Koch (l.c., p. 323), wind instruments, however, should not be "eingeblasen" (blown-in) by an unskilled player.

As the reader will have perceived, opinions differ widely. One says that playing-in is not necessary, another that it is, but that it requires a skilful player, whereas a third, as we shall see, tells us that a violin may be improved by purely mechanical means.

Savart* says that even a glass rod is capable of being "played-in." If such a rod has repeatedly been made to vibrate longitudinally and is then broken, a certain time will elapse before the rod will be able to vibrate regularly again: "Il semblerait que la répétition fréquente des mêmes vibrations apporte des changements dans la disposition des molécules."†

Non-varnished Violin.

According to Savart,‡ the sound of a new violin, if unvarnished, soon becomes weak. He imputes this to the moisture of the air, and maintains that unvarnished wood, being more or less moist, undergoes a considerable change by a continued state of vibration. As an example, he mentions the soundboard of a piano: "Les ébranlements

---

* "Ann. de Chim. et de Phys., T. XIV, 1820, p. 119.

† Translation: "It would seem that the frequent repetition of the same vibrations produces changes in the disposition of the molecules."

A tail-piece of peculiar form is made by the British Resonatone Company, 16 Brook Street, Bond Street, London, W. The maker asserts that when using this, the playing-in of a new violin is unnecessary. As far as the experience of one of my friends and of myself goes, this tail-piece is neither better nor worse than the usual one. For its excellent qualities and the "principle" on which it is based, I refer to the pamphlet delivered with it. As with all inventions of this kind, a great many recommendations of the "Resonatone" have been received and appear in the pamphlet. I ought to add that the apparatus looks very neat, and can easily be fitted to any bow instrument (violin, viola and violoncello) without any alteration to the instrument, so that the old tail-piece can always be replaced.

‡ "Mémoire," l.c., p. 71.

communiqués à la table . . . . détruisent peu a peu la contexture du bois en expulsant un grand nombre de particules sous forme de poussière."* When such a soundboard is being cut up, he says, it will be seen to be very porous.

Savart seems to forget, however, that only the outside of the violin is varnished. It is true that the varnish penetrates to some extent into the wood, but the inside of the violin shows so little of this, that without doubt the moisture of the air will still have an influence.

In the "Zeitschrift für Instrumenten-bau," 36, 1915-6, p. 4, an article is to be found, "Zur Impregnierung der Klanghölzer an Violinen und Piano's."

The writer of this article—like so many others—says therein that violins improve by being played upon, and as the cause of this he mentions that the molecules by internal friction of the wood wear out and become rounded, like the rolling stones in a river's bed, and that this causes them to be put into vibration more easily. Something like Savart's assertion, therefore. He supposes the old Italian masters to have had some means to loosen ("lockern") the molecules, so that they became more movable. For this purpose he uses an impregnating substance, before varnishing the belly and back. Without this, he continues, the varnish penetrates too far into the wood, and prevents the molecules from moving freely.

In the same article rather singular ideas are expressed about molecular motion and the motion of the air between the molecules. It is also said that the sound of the violin is not caused by transverse motion of the belly and back.

In the same volume of that periodical (p. 47) Heinrich Baumann prints an article, "Ueber die Homogenisierung der Resonanzkörper und den Bau der Violine." As an impregnating liquid he uses "terebinthe," with which back

* Translation: "The shocks of the vibrations communicated to the sound-board . . . . gradually destroy the texture of the wood by forcing out a great number of particles in the form of dust."

and belly are treated on both sides. He considers that this renders the wood homogeneous.

I do not believe this to be possible, as the grain of the wood will always be much harder than the interjacent parts. And, as we have seen, on p. 52, homogeneousness is not to be desired, as the *form* of the violin is in accordance with the wood *not* being homogeneous.

Playing-in by Mechanical Means.

Otto* gives the following method for playing-in a violin in two or three months' time: he takes a heavier bow than is ordinarily used, holds the violin between his knees and draws it across each of the open strings for a quarter of an hour. Then he ties a silk cord round the neck of the violin, on the spot where the first finger would stop the notes G sharp, D′ sharp, A′ sharp and E″ sharp, in the half position. The cord must be sufficiently thick to stop the string when a pressure from the bow is applied, so that the above-named notes will be heard. After having played each of these notes in the same manner for fifteen minutes, the cord is tied so as to stop A, E′, B′ and F″ sharp, and so on, till all the notes on the four strings have been treated in the same manner.

As far as I know, this method has never come into use. If a good violin-player is required for "playing-in," this method must be wrong. If, on the other hand, no skilled player is necessary, and any violinist suffices who does not play out of tune, then Otto's method might be useful.

But in that case it would probably do as well to use steel strings and put them into vibration electro-magnetically. The object could then be attained much sooner, as the performance could be continued day and night. Or, if gut strings were preferred, the strings might be

* Otto, l.c., p. 62. This method is also mentioned by O. Bachmann, l.c., p. 59.

moved by small rollers, as used on the electrical violin.* There exists also an automatic violin, the strings of which are vibrated by an endless band. This method might likewise be applied, the four strings might then all be made to vibrate simultaneously.

The Usefulness of Playing-in cannot be Proved with Certainty.

As long as no method exists for investigating by physical means the division of the belly and the motion of its different parts, no definite answer can be given to the question whether a violin really improves by being played upon well and over a long period.

---

* "Electrical World" (New York), Vol. 55, No. 12, p. 763. The idea of making the strings vibrate by means of rollers is not new. It was tried about 1730 by Risch, in Weimar (Sandys and Forster, "The History of the Violin," 1864, p. 164). It is much older, however. Mersenne (l.c., p. 164) mentions it, and says: "Les Allemans font voir par experience que les Clauecins sont capables de faire ouyr d'excellens concerts de violes par le moyen des roües qui suppleent les traits de l'archet." [Translation: "The Germans have shown experimentally that harpsichords can produce excellent concerts of viols by means of wheels which supply the strokes of the bow."] The strings of the "vielle" were also put into vibration by a rotating disc. See the figure in Mersenne, l.c., p. 212.

CHAPTER X.

The Mute.

Function of the Mute.

ALTHOUGH the mute does not form an integral part of the violin, we will briefly mention its function. After what has been said in Chapter II, this can be done in a few lines.

Apian-Bennewitz* says: "Diese Wirkung des Dämpfers bezieht sich auf die Thätigkeit des Steges als Uebermittler der Saitenschwingungen auf die Decke und ist nur so erklärbar dass er die Umwandlung der wagerechten Schwingungen durch die Einklemmung des obersten Stegtheils stört und durch seine Schwere die rückläufigen Schwingungen hemmt."† This is saying only that the mute hampers the motion of the bridge.

Later on he says: "Der Dämpfer wirkt jedoch nicht nur durch seinen Druck auf die Seitenflächen des Steges, sondern auch durch seine Schwere, oder den Druck, den er senkrecht auf den Steg und die Decke ausübt."‡

---

* Apian-Bennewitz, l.c., p. 31.

† Translation: "This effect of the mute has reference to the action of the bridge as transmitter of the vibrations of the strings to the belly, and is explainable only in the manner that it hinders the transformation of the horizontal vibrations by the squeezing of the upper part of the bridge, and checks by its weight the returning vibrations."

‡ Translation: "The mute does not act only by pressure upon the sides of the bridge, but by the weight or the pressure which it exercises perpendicularly to the bridge and the belly."

Evidently this small augmentation of pressure, caused by the mute, is of no consequence when compared with the pressure exercised by the strings upon the bridge and the belly. None of the two communications of Apian-Bennewitz explains the change of timbre caused by the mute. It is evident that we have to deal here with an augmentation of the moment of inertia and not with an increase of pressure.

THE END.

CATALOGUE OF
BOOKS ON MUSIC

Literature covering every branch of Music, Biographical and Critical Studies of Composers, Histories of Musical Instruments, also valuable Textbooks and Tutors for Teachers and Students of the Piano, Organ, Violin, Cello, Theory, Singing, etc.

All prices are net and postage extra

Published by

WILLIAM REEVES Bookseller Limited

1a Norbury Crescent, London, S.W.16

Phone POLlards 2108

ÆSTHETICS, CRITICISMS, ESSAYS.

PAN PIPES, THE SPIRIT OF MUSIC in Nature, Art and Legends, from East to West. Sixteen Articles for General Reading, with Drawings of Eastern Musical Instruments. By G. P. GREEN. Crown 8vo, cloth, 7s. 6d. *net.*

HOW TO LISTEN TO GOOD MUSIC and Encourage the Taste in Instrumental and Vocal Music. With many useful Notes for Listener and Executant. By K. BROADLEY Greene. Complete, cloth, 6s. net; or in two books, paper, 2s. 6d. *net* each.

MOZART, WEBER AND WAGNER, with Various other Essays on Musical Subjects. By HECTOR BERLIOZ. Translated from the French by EDWIN EVANS, F.R.C.O. Crown 8vo, cloth, 15s. net.

A charming Book of Musical Essays.

SOME FAMOUS SYMPHONIES, How to Understand Them. With their Story and Simple Analysis. Numerous Portraits. By J. F. PORTE. Dealing with Symphonies of Beethoven, Berlioz, Borodin, Brahms, Chausson, Dvorák, Elgar, César Franck, Haydn, Mendelssohn, Mozart, Schubert, Stanford and Tchaïkovsky. Complete in cloth, 8s. *net*, or in 2 separate parts, paper, 2s. 6d. *net* each.

For the general reader and musician alike.

THE DEATH AND RESURRECTION OF THE MUSICAL FESTIVAL. By RUTLAND BOUGHTON. 8vo, sewed, 2s. *net.*

The Decay of Triennials—The Rise of Competitions—The Reform of Competitions—The Festival of the Future.

SOME ASPECTS OF CHINESE MUSIC AND SOME THOUGHTS AND IMPRESSIONS ON ART PRINCIPLES IN MUSIC. By G. P. GREEN. Post 8vo, cloth, 6s. *net,* paper covers, 3s. 6d. *net.*

THE FUTURE OF MUSIC. Coming Changes Outlined in Regard to Composer, Conductor and Orchestra. By LOUIS LALOY. Translated by MRS. FRANZ LIEBICH. 8vo, cloth, 3s. 6d. *net*; paper, 2s. *net.*

SOME ASPECTS OF GIPSY MUSIC. By D. C. PARKER. Post 8vo, cloth, 6s. *net* (or paper covers, 3s. 6d. *net*).

MUSIC AND MUSICIANS. Essays and Criticisms, by ROBERT SCHUMANN. Translated, Edited and Annotated by F. R. RITTER. Portrait of Robert Schumann, photographed from a Crayon by BENDEMANN. First Series, Eighth Edition. Crown 8vo, cloth, 419 pages, 21s. net.

Ditto. Second Series. Fourth Edition, with a Contents-index added. Crown 8vo, cloth, 540 pages, 21s. net.

THE DEEPER SOURCES OF THE BEAUTY AND EXPRESSION OF MUSIC. By Joseph Goddard. With many Musical Examples. Crown 8vo, cloth, 7s. 6d. *net.*

WOMAN AS A MUSICIAN. An Art Historical Study. By F. R. Ritter. 8vo, sewed, 3s. *net.*

MUSICAL DEVELOPMENT, or Remarks on the Spirit of the Principal Musical Forms. An Æsthetical Investigation, in which an Attempt is made to show the Action in Music of certain Laws of Human Expression; to point out what are the Spiritual Aims of the Chief Forms of Composition, and the Broad Principles upon which they should be Constructed. By Joseph Goddard. 8vo, cloth, 10s. *net.*

IN THE SERVICE OF ART. A Plea for Simplicity in Music. By J.-Joachim Nin. Translated by Mrs. Franz Liebich. Post 8vo, 2s. 6d. *net.*

THE PLACE OF SCIENCE IN MUSIC. By H. Saint-George. Advanced Students of Harmony. With music examples. 8vo, sewed, 2s. 6d. *net.*

NECESSITY OF MUSIC IN THE SCHOOL CURRICULUM. Address delivered to Members of the Music Teachers' Association. By A. W. Pollitt, *Mus.D., F.R.C.O.* 8vo, sewed, 1s. 6d. *net.*

ÆSTHETICS OF MUSICAL ART, or The Beautiful in Music. By Dr. Ferdinand Hand. Translated from the German by Walter E. Lawson, Mus.Bac. Cantab, etc. Third Edition. Crown 8vo, cloth, 10s. *net.*

NATIONAL SCHOOL OF OPERA FOR ENGLAND. Being the Substance of a Paper read at Trinity College, London. By Frank Austin. 1s. *net.*

MATERIAL OF MELODY and Early Steps in Musical Art. By J. H. Lewis. 6d. *net.*

MUSIC IN THE HIRSCH LIBRARY (Part 53 of the Catalogue of Printed Music in the British Museum), by A. Hyatt King and C. Humphries, 1951. Published for the Trustees of the British Museum. This catalogue, prepared by the Museum staff, lists also a considerable number of works which were either not included in the original four volume catalogue by P. Hirsch, or were acquired later. 4to, cloth, £2 2s. *net.*

BOOKS ABOUT MUSICIANS AND THEIR WORKS.

I.—COLLECTED.

ON RUSSIAN MUSIC. Critical and Historical Studies of Glinka's Operas, Balakirev's Works, etc. With chapters dealing with Compositions by Borodin, Rimsky-Korsakov, Tchaïkovsky, Mussorgsky, Glazunov, and various other Aspects of Russian Music. By GERALD ABRAHAM. With Frontispiece and 88 Music Examples. 8vo, cloth, 18s. *net.*

Companion to the same author's "Studies in Russian Music."

STUDIES IN RUSSIAN MUSIC. Critical Essays on the most important of Rimsky-Korsakov's operas, Borodin's "Prince Igor," Dargomïzhsky's "Stone Guest," etc.; with chapters on Glinka, Mussorgsky, Balakirev and Tschaïkovsky. By GERALD ABRAHAM. 92 music examples. 350 pages, crown 8vo, cloth, 21st. *net.*

FROM MENDELSSOHN TO WAGNER. Being the Memoirs of J. W. Davison, forty years Music Critic of *The Times,* compiled by his son, HENRY DAVISON, from Memoranda and Documents. With 52 portraits of Musicians and Important Letters (previously unpublished) of Mendelssohn, Berlioz, Gounod, Jullien, Macfarren, Sterndale Bennett, etc. Index, 539 pages, 8vo, cloth, 25s. *net.*

WITH THE GREAT COMPOSERS. A Series of Pen Pictures, exhibiting in the form of Interviews the Personal Characteristics as Artists of the World's great Tone Poets. By GERALD CUMBERLAND. Portraits. Cr. 8vo, cloth, 10s. *net.*

Deals with Chopin, Haydn, Mendelssohn, Paganini, Beethoven, Handel, Rossini, Schubert, Liszt, Berlioz, Mozart, Wagner, Tchaïkovsky, Cherubini, Wolf, Borodin, Schumann, Sullivan.

THE SYMPHONY WRITERS SINCE BEETHOVEN. Critical Essays on Schubert, Schumann, Götz, Brahms, Tchaïkovsky, Brückner, Berlioz, Liszt, Strauss, Mahler, Mendelssohn, Saint-Saëns, etc. By FELIX WEINGARTNER. Translated by A. BLES. Twelve Portraits. *Second Impression.* With Chapter added by D. C. PARKER on Weingartner's Symphony No. 5. Crown 8vo, cloth, 12s. 6d. *net.*

REEVES' DICTIONARY OF MUSICIANS. Biographical Accounts of about 2,500 Noteworthy Musicians of the Past and Present. Edited by EDMUNDSTOUNE DUNCAN and Others. Crown 8vo, cloth, 7s. 6d. *net* (paper covers, 4s. *net*).

SKETCHES OF GREAT PIANISTS AND GREAT VIOLINISTS. Biographical and Anecdotal, with Account of the Violin and Early Violinists. Viotti, Spohr, Paganini, De Beriot, Ole Bull, Clementi, Moscheles, Schumann (Robert and Clara), Chopin, Thalberg, Gottschalk, Liszt. By G. T. FERRIS. Third Edition. Crown 8vo, cloth, 8s. 6d. *net*.

SKETCHES OF ENGLISH GLEE COMPOSERS. Historical, Biographical and Critical. From about 1735-1866. By D. BAPTIE. Post 8vo, cloth, 8s. 6d. *net*.

ENGLISH GLEE AND MADRIGAL WRITERS. By W. A. BARRETT. 8vo, cloth, 6s. *net* (paper covers, 3s. 6d. *net*).

SOME MUSICAL RECOLLECTIONS OF FIFTY YEARS. By RICHARD HOFFMAN. With Memoir by MRS. HOFFMAN. Illustrated with many Portraits. Crown 8vo, cloth, 10s. *net*.

MUSICAL MEMORIES. By WILLIAM SPARK, *Mus.Doc.* (*late Organist of the Town Hall, Leeds*). Third Edition. With sixteen Portraits. Thick crown 8vo, cloth, 10s. *net*.

BIOGRAPHICAL DICTIONARY OF FIDDLERS. Including Performers on the Violoncello and Double Bass, Past and Present. Containing a Sketch of their Artistic Career, together with Notes of their Compositions. By A. MASON CLARKE. Nine Portraits. Post 8vo, cloth, 10s. *net*.

HOW TO STUDY THE PIANOFORTE WORKS OF THE GREAT COMPOSERS. By HERBERT WESTERBY, Mus.Bac. Handel, Bach, Haydn, Scarlatti, Mozart, Clementi, C. P. E. Bach, Beethoven. With 123 Musical Examples. Crown 8vo, cloth, 12s. 6d. *net*.

The following issued singly, paper covers:
HANDEL, 1s.; D. SCARLATTI, 1s.; J. S. BACH, 1s. 6d.; C. P. E. BACH AND HAYDN, 1s.; CLEMENTI, 1s.; MOZART, 1s. 6d.

BRITISH MUSICAL BIOGRAPHY. A Dictionary of Musical Artists, Authors and Composers born in Britain and its Colonies. By J. D. BROWN and S. S. STRATTON. 8vo, cloth, 21s. *net.*

Despite its age, this book is still of importance because it contains particulars of many musicians not listed elsewhere.

THE CRITICAL WRITINGS OF HECTOR BERLIOZ

A CRITICAL STUDY OF BEETHOVEN'S NINE SYMPHONIES, with a few Words on his Trios and Sonatas, and a Criticism of Fidelio. Portrait. Crown 8vo, cloth, 21s. *net.*

GLUCK AND HIS OPERAS, with an Account of their Relation to Musical Art. Portrait. Crown 8vo, cloth, 15s. *net.*

MOZART, WEBER AND WAGNER, with various other Essays on Musical Subjects. Crown 8vo, cloth, 15s. net.

The above three books form a full and readable translation by Edwin Evans of the justly celebrated critical writings of Hector Berlioz issued under the title of "A Travers Chant."

BOOKS ABOUT MUSICIANS AND THEIR WORKS.

II.—INDIVIDUAL.

A DIGEST OF THE ANALYSES OF J. S. BACH'S FORTY-EIGHT CELEBRATED FUGUES FROM THE WELL-TEMPERED CLAVIER (Das Wohltemperirte Klavier). With over 1,600 Music Examples and 46 Tables. Compiled by BROOK SAMPSON, F.R.C.O. Cloth, 30s. *net.*

THE FORTY-EIGHT FUGUES IN THE WELL-TEMPERED CLAVIER (Das Wohltemperirte Klavier). By J. S. BACH. Analysed by BROOK SAMPSON, Mus.Bach. Oxon., F.R.C.O.

Following obtainable, 1s. 6d. *net each.*

No. 4, in C sharp minor	No. 29, in D major
No. 9, in E major	No. 34, in E minor
No. 16, in G minor	No. 36, in F minor
No. 18, in G sharp minor	No. 38, in F sharp minor
No. 24, in B minor	No. 40, in G minor
No. 28, in C sharp minor	

OUTLINE ANALYSIS OF BACH'S FORTY-EIGHT FUGUES. By BROOK SAMPSON. 3s. *net.*

BALFE, HIS LIFE AND WORK. By WM. ALEXANDER BARRETT. Over 300 pages. Crown 8vo, cloth, 12s. 6d. *net.*

A CRITICAL STUDY OF BEETHOVEN'S NINE SYMPHONIES, with a Few Words on His Trios and Sonatas, a Criticism of "Fidelio" and an Introductory Essay on Music. By HECTOR BERLIOZ. Translated from the French by EDWIN EVANS. Portrait. Crown 8vo, cloth, 21s. *net.*

BEETHOVEN AND HIS PIANO WORKS (Sonatas, Concertos, Variations, etc.). Descriptive and Analytic Aid to their Understanding and Rendering. By HERBERT WESTERBY. With list of Principal Editions and Bibliography. 3 illustrations, 45 music examples. Crown 8vo, cloth, 10s. *net.*

BEETHOVEN'S PIANOFORTE SONATAS Explained for the Lovers of the Musical Art. By ERNST VON ELTERLEIN. Translated by E. HILL, with Preface by ERNST PAUER. Revised Edition (the Seventh issue). With Portrait, and View of Beethoven's House. Crown 8vo, cloth, 10s. *net.*

"He writes with the ripe knowledge and thorough understanding of a practical musician. Every musical student or amateur can safely trust him as a competent and agreeable guide."—E. PAUER.

BEETHOVEN'S NINE SYMPHONIES Fully Described and Analysed. A complete Account of Thematic Material and auxiliary Motives, an Analytical Chart of each Movement, full Technical Descriptions of Developments. Particulars of Formal and Rhythmic Features, Epitomical Tables, etc. Illustrated by 637 Musical Examples. By Edwin Evans. Cloth, Vol. I (Nos. 1 to 5), 17s. 6d. net. Vol. II (Nos. 6 to 9), out of print.

BEETHOVEN'S SYMPHONIES in their Ideal Significance. Explained by Ernst von Elterlein. Translated by Francis Weber. With an Account of the Facts Relating to Beethoven's Tenth Symphony. By L. Nohl. Second Edition. Crown 8vo, cloth, 10s. net.

BEETHOVEN'S SYMPHONIES Critically Discussed by Alexander Teetgen. With Preface by John Broadhouse. Second Edition. Post 8vo, cloth, 6s. 6d. net.

BEETHOVEN'S PIANO SONATAS. A Descriptive Commentary on the Sonatas in the light of Schnabel's Interpretations; giving an æsthetic Appreciation of each Sonata, with an Outline of the Development of the Sonata Form in Beethoven's hands. With a Biographical Sketch of Schnabel and an account of his activity as an executant, composer and teacher. By Rudolf Kastner. Translated by Gerald Abraham. 55 pages, post 8vo, paper, 3s. 6d. net.

NOTES ON THE INTERPRETATION OF 24 FAMOUS PIANO SONATAS BY BEETHOVEN. By J. Alfred Johnstone. Portrait, crown 8vo, cloth, 12s. 6d. net.

BEETHOVEN. By Richard Wagner. With a Supplement from the Philosophical Works of Arthur Schopenhauer. Translated by Edward Dannreuther. Third Edition Crown 8vo, cloth, 12s. net.

"It is a plain duty to be familiar and even intimate with the opinion of one famous man about another. Gladly therefore we welcome Mr. Dannreuther's translation of the work before us. Mr. Dannreuther has achieved his task with the conscientiousness of his nature and with a success due to much tact and patience."—*Musical Times.*

"This work contains his contributions towards the metaphysics of music, if, indeed such can be said to exist. Apart, however, from metaphysics, the work is an exposition of Wagner's thoughts on the significance of Beethoven's music."—*Grove's Dictionary.*

BORODIN THE COMPOSER AND HIS MUSIC. A Descriptive and Critical Analysis of his Works and a Study of his Value as an Art Force. With many references to the Russian Kouchka Circle of Five—Balakirev, Moussorgsky, César Cui, Rimsky-Korsakov, and Borodin. By Gerald Abraham. With music examples and 5 Portraits. Thick crown 8vo, cloth, 15s. net.

LIFE OF JOHANNES BRAHMS. By Florence May. Second Edition. Revised by the Author, with additional matter and Illustrations, and an Introduction by Ralph Hill. In 2 vols., 8vo, cloth, 35s. net.

CHOPIN, HIS LIFE AND LETTERS. By Moritz Karasowski. Translated by Emily Hill. Third Edition, with additional Letters in Polish with English translation, Chopin to Grzymala, and extra Illustrations. Fourteen Illustrations. Crown 8vo, cloth, £2 2s. net.

Karasowski was a close friend of the family of Chopin and was intimate with them for several years. He was given access to the letters, many of which were subsequently destroyed during the Warsaw insurrection, written by Chopin to his family in Poland throughout his life abroad. These facts give this work particular value, and to it we are also indebted for valuable information regarding Chopin's life.

CHOPIN'S GREATER WORKS (Preludes, Ballads, Nocturnes Polonaises, Mazurkas). How they should be Understood. By J. Kleczynski. Including Chopin's Notes for a "Method of Methods." Translated by N. Janotha Second Edition. With music examples. Crown 8vo, cloth, 8s. 6d. net.

HOW TO PLAY CHOPIN. The Works of Chopin, their Proper Interpretation. By J. Kleczynski. Translated by A. Whittingham. Sixth Edition. Music Illustrations. Crown 8vo, cloth, 7s. 6d. net.

Contains the cream of Chopin's instructions to his own pupils. To admirers of Chopin and players of his music we should say this book is indispensable.

FREDERIC CHOPIN, Critical and Appreciative Essay. By J. W. Davison. 8vo, 3s. net.

CHOPIN AS REVEALED BY EXTRACTS FROM HIS DIARY. By Count Tarnowski. Translated from the Polish by N. Janotha. With eight Portraits. Crown 8vo, paper covers, 5s. net.

In the above notes Chopin alludes to many of his compositions as well as relating the conditions under which they were written.

CHOPIN THE COMPOSER AND HIS MUSIC. An Analytic Critique of Famous Traditions and Interpretations, as exhibited in the Playing of Great Pianists, Past and Present. By John F. Porte. With portrait. 193 pages, crown 8vo, cloth, 10s. 6d. net.

"Your excellent book gives me supreme pleasure. You judge tradition so well. I thank you for your artistic sympathy and your wonderful book."—MORITZ ROSENTHAL.

HANDBOOK TO CHOPIN'S WORKS. A Detailed Account of all the Compositions of Chopin. Short Analyses for Piano Student and Critical Quotations from Writings of Well-known Musical Authors. Chronological List of Works, etc. By G. C. A. Jonson. Second Edition. Crown 8vo, cloth, 18s. net.

"Here in one compact volume is all that is necessary to know about Chopin and his works except by the leisured enthusiast."

LIFE OF CHERUBINI. By F. J. Crowest. (Great Musicians Series). Crown 8vo, cloth, 6s. net.

CHERUBINI. Memorials illustrative of his life. By E. Bellasis. Crown 8vo, cloth, 15s. net.

GLUCK AND HIS OPERAS. With an Account of their Relation to Musical Art. By Hector Berlioz. Translated from the French by Edwin Evans. Portrait. Crown 8vo, cloth, 15s. net.

HANDEL'S MESSIAH. The Oratorio and its History. A Handbook of Hints and Aids to its Public Performance, with useful Notes on each Movement, as well as Numerous References and much Original Information. By J. Allanson Benson. Cloth, 6s. net (paper 3s. net).

LISZT, COMPOSER, AND HIS PIANO WORKS. Descriptive Guide and Critical Analysis, written in a popular and concise style. By Herbert Westerby, Mus.Bac., Lon., etc. 5 illustrations, 24 music examples. 336 pp., crown 8vo, cloth, 12s. 6d. net.

THE ORGAN PARTS OF MENDELSSOHN'S ORATORIOS AND OTHER CHORAL WORKS Analytically Considered. By Orlando A. Mansfield, Mus.Doc., F.R.C.O. Numerous Musical Examples. Crown 8vo, cloth, 10s. net.

HOW TO INTERPRET MENDELSSOHN'S "SONGS WITHOUT WORDS" (the celebrated "Lieder ohne Worte"). A Readable and Useful Guide for All. Gives the Piano Students helpful Insight into the first Principles of Form in Music. By Charles W. Wilkinson. With portrait and facsimile of MS. Crown 8vo, cloth, 6s. net (paper, 3s. 6d. net).

These notes on each of the "Lieder" will help the student in playing these homely and easily intelligible compositions.

ANALYSIS OF MENDELSSOHN'S ORGAN WORKS. A Study of their Structural Features. By Joseph W. G. Hathaway, Mus.B. Oxon. 127 Musical Examples. Portrait and Facsimiles. Crown 8vo, cloth, 8s. 6d. net.

MOZART: a Commemorative Address read before the Positivist Society. By V. Lushington. 8vo, 2s. net.

Mozart and Religion.

MOZART AND THE SONATA FORM: A Companion Book to any Edition of Mozart's Piano Sonatas, including an Analysis of the Form of each Movement, with Notes upon Treatment and Tonality, by J. Raymond Tobin, Mus.B. Crown 8vo, cloth, 10s. net.

THE SONATA: Its Form and Meaning, as Exemplified in the Piano Sonatas by Mozart. A Descriptive Analysis, with Musical Examples. By F. Helena Marks. 8vo, cloth, 15s. net.

QUESTIONS ON MOZART'S SONATAS. By F. Helena Marks. Aid and Companion to the Study of the Author's work, "The Sonata: Its Form and Meaning as Exemplified in the Piano Sonatas by Mozart." 2s. 6d. net.

PURCELL. By William H. Cummings, Mus.Doc. (Great Musicians Series). 8vo, cloth, 10s. net.

RACHMANINOFF. An Exhilarating Biographical Study of this Genius of the Keyboard. By Watson Lyle. With Records, also his Playing of other Composers' Works. Critical Survey of his Works as recorded on Gramophone Preface by Leff Pouishnoff. Two Portraits and List of Works. Crown 8vo, cloth, 15s. net.

FRANZ SCHUBERT, Man and Composer. A Vivid Story of a Charming Personality. By C. Whitaker-Wilson. With Original Translations into English of eight Well-known Schubert Songs, together with the Music for the Voice. Portraits and Illustrations of Schubert and his Friends. Crown 8vo, cloth, 15s. net.

HENRY SMART'S ORGAN COMPOSITIONS ANALYSED. By J. Broadhouse. Crown 8vo, cloth, 5s. net.

TEMPLETON AND MALIBRAN. Reminiscences of these Renowned Singers, with Original Letters and Anecdotes. Three Authentic Portraits by Mayall. 8vo, cloth, 10s. net.

WAGNER'S TEACHINGS BY ANALOGY. His Views on Absolute Music and of the Relations of Articulate and Tonal Speech, with Special Reference to "Opera and Drama." By Edwin Evans. Crown 8vo, cloth, 6s. net; paper, 3s. 6d. net.

WAGNER'S PARSIFAL. And the Bayreuth Fest-Spielhaus. By N. Kilburn. Paper, 1s. net.

WAGNER, 1849. A Historical Retrospect in vindication of Wagner. By William Ashton Ellis. Cloth 3s. 6d. net (paper 2s. net).

OPERA AND DRAMA. By Richard Wagner. Translated by Edwin Evans. Opera and the Essence of Music, The Stage-Play and Dramatical Poetic Art in the Abstract, Poetry and Music in the Drama of the Future. 2 vols. Crown 8vo, cloth, 30s. net.

The value of the study of Wagner's prose writing as an education to the musical student cannot be over-estimated, and amongst these prose writings "Opera and Drama" may be considered his principal critical and theoretical production. Without a study of its contents no true and lasting understanding of opera can be arrived at.

Wagner writing to his friend Uhlig said:

"Here you have my testament; I may as well die now—anything further that I could do seems to me a useless piece of luxury."

Ernest Newman in "A Study of Wagner," writes: "Although there appears here and there in his prose-work something of the vast synthetic power of his musical imagination—such a work as 'Opera and Drama,' for instance, finally compelling our admiration for its tenacity of purpose and the breadth of vision that sweeps so far before and after."

WAGNER'S PROSE WORKS. Translated by Wm. Ashton Ellis. Vol. I, The Art-Work of the Future, etc., 21s. net; Vol. II, Opera and Drama, out of print; Vol. III, The Theatre, 21s. net; Vol. IV, Art and Politics, 21s. net; Vol. V, Actors and Singers, out of print; Vol. VI, Religion and Art, out of print; Vol. VII, In Paris and Dresden, 35s net; Vol. VIII, Posthumous, etc., 35s. net.
Complete sets are occasionally available. Apply to the publishers of this list for particulars.

DIARY OF A PILGRIM IN THE NETHERLANDS. The Holy Grail in Bruges and Other Impressions of Travel. Bruges, Courtrai, Tournai, Amsterdam, the Hague, Antwerp. By Rose Koenig. Crown 8vo, cloth, 3s. 6d. net (paper covers, 2s. net).

HOW TO UNDERSTAND WAGNER'S "RING OF THE NIBELUNG." Being the Story and a Descriptive Analysis of the "Rheingold," the "Valkyr," "Siegfried" and the "Dusk of the Gods." With Musical Examples of the Leading Motives of Each Drama. By Gustave Kobbe. Together with a Sketch of Wagner's Life. By N. Kilburn, Mus.Bac. Cantab. Seventh Edition. Crown 8vo, cloth, 10s. net.

Description and analysis go hand in hand with the narration of the story. Musical examples are given as aids to the identification of the leading motives and an index makes it easy for any reader to turn up any particular motive instantly.

MY RECOLLECTIONS OF RICHARD WAGNER. By August Lesimple. Post 8vo, cloth, 3s. 6d. net (paper covers, 2s. net).

WAGNER. A sketch of his Life and Works. By N. Kilburn, Mus. Bac. Cantab. Paper, 1s. net.

ON CONDUCTING. By Richard Wagner. Translated by Edward Dannreuther. A Treatise on Style in the Execution of Classical Music. Fourth Edition. Crown 8vo, cloth, 7s. 6d. net.

"One of the finest of his minor publications, and to the professional musician, perhaps the most instructive, giving his views as to the true way of rendering classical music, with numerous directions how to do it, and how not to do it, together with many examples in musical type from the instrumental works of Beethoven, Weber, Mozart, etc."—*Grove's Dictionary.*

WAGNER'S Ring des Nibelungen. The Story of Wagner's "Ring" for English Readers. By N. Kilburn, Mus.Bac., Cantab. Crown 8vo, paper, 2s. net.

THREE IMPRESSIONS OF BAYREUTH. The 1908 and Previous Wagner Festivals. By Rose Koenig. A Record in the Form of a Diary of Visits extending over eight years. Crown 8vo, cloth, 3s. 6d. net (paper, 2s. net).

OUT-OF-PRINT BOOKS.
Positive Microfiches can be supplied of the following books where the printed editions are out of print.

ELIZABETHAN VIRGINAL MUSIC AND ITS COMPOSERS. By M. H. Glyn. Second edition, 1934, £1 net.

HISTORY OF THE VIOLONCELLO, Viola da Gamba, etc., with Biographies of all the Most Eminent Players, 1915. By E. van der Straeten, £2 10s. net.

HISTORY OF MUSIC, AND OF MUSICAL INSTRUMENTS.

STRINGED INSTRUMENTS OF THE MIDDLE AGES. Their Evolution and Development. By Hortense Panum. English edition, revised and edited by Jeffrey Pulver. A detailed and comprehensive history, with illustrations, of the evolution of the mediæval stringed musical instruments from their first appearance in the records of the earliest civilisations, through their gradual development in the Greek, Roman and Christian eras down to more recent times. 400 illustrations. 8vo, cloth, pp. ix, 511, £2 10s. net.

Many years of travel and research were necessary to make the production of this work possible. The author, in addition, has most painstakingly searched mediaeval literature and the records of contemporary art for references to and descriptions of the instruments dealt with, and it is believed that the account here given of them is as complete as it is possible to make it.

The book is most generously illustrated and carefully indexed by the editor. No pains have been spared to secure drawings or photographs of practically every type mentioned.

TRIBAL MUSIC AND DANCING IN THE SOUTHERN SUDAN, at Social and Ceremonial Gatherings. A descriptive account of the music, rhythm, etc., from personal observation. By Dr. A. N. Tucker. 5 illustrations, 61 music examples illustrating the dances, songs and rhythm. 57 pages, demy 8vo, cloth, 10s. 6d. net.

HISTORY OF THE TRUMPET of Bach and Handel. A New Point of view and New Instruments. Forming a History of the Trumpet and its Music, from its earliest use as an artistic instrument to the middle of the 18th century. Special reference given to its employment by Bach and Handel, and the correct modern performance of the old parts; including a description of the new instrument invented by the author for this purpose. By Werner Menke. Translated by Gerald Abraham. With 5 plates and music supplement. English and German text. 233 pages, crown 8vo, cloth, 18s. net.

THE BOWED HARP. A Study of the History of Early Musical Instruments. By Otto Andersson, Ph.D., President of the Swedish University at Abo. From the Original Swedish Edition, revised by the Author. The Translation Edited with additional footnotes by Kathleen Schlesinger. 116 Illustrations, Bibliography and Index. 340 pages, 8vo, cloth, 30s. net.

"A valuable contribution to the literature about early musical instruments."—*The Strad.*

MUSIC OF THE MOST ANCIENT NATIONS, Particularly of the Assyrians, Egyptians and Hebrews; with special reference to Discoveries in Western Asia and in Egypt. By CARL ENGEL. This issue has large size reproductions of Harp unearthed at Ur (1928), and of Silver Military Trumpet from the Tomb of Tut-Ankh-Amen in the Valley of the Kings (unearthed 1926). The volume has about 100 illustrations. Thick 8vo, cloth, 30s. *net*.

STORY OF INDIAN MUSIC AND ITS INSTRUMENTS. A Study of the Present and a Record of the Past. Together with Sir William Jones' celebrated Treatise in full. With 19 Plates, chiefly of Instruments, 7 Music Illustrations and a Map. By ETHEL ROSENTHAL, *A.R.C.M., F.R.G.S.* Crown 8vo, cloth, 21s. *net*.

OPERA STORIES OF TO-DAY AND YESTERDAY, Retold Act by Act (including Wagner's 5 "The Ring" Operas). By EDMONDSTOUNE DUNCAN. Complete, cloth, 6s. 6d. *net*.

A racy account of the plots and histories of fifty famous operas, from Purcell, Gluck and Mozart, to Richard Strauss and Ethel Smyth.

OLD ENGLISH PSALMODY. By W. T. BROOKE. First Series: From the Accession of Edward VI to the Restoration of Charles II, 1547-1660. Second Series: Psalmists from 1660-1800. Crown 8vo, paper covers, 3s. 6d. *net* each series.

THE GIPSY IN MUSIC. By FRANZ LISZT. Englished for the first time by EDWIN EVANS, *Senior*, and preceded by an Essay on Liszt and his Work.

Gipsy and Jew, Two Wandering Races.
Gipsy Life in Relation to Art.
Gipsy Music and Musicians.

The result of the Author's long Experience and Investigations of the Gipsies and their Music. With Portraits of the Author, etc. In two handsome volumes, 8vo, cloth, 30s. *net*.

ARABIC MUSICAL MANUSCRIPTS IN THE BODLEIAN LIBRARY. Plate of two Musical Instruments from early Arabic Manuscripts. By H. G. FARMER, *M.A., Ph.D.* 8vo, sewed, 10s. *net*.

HISTORY OF THE HARP. From the Earliest Period. By JOHN THOMAS *(Pencerdd Gwalia)*. 8vo, paper covers, 6s. *net*.

THE SOURCES OF KEYBOARD MUSIC IN ENGLAND. By CHARLES VAN DEN BORREN, translated by J. E. Matthew. 378 pages, 237 music examples. Crown 8vo, cloth, £1 1s. *net.*

A standard European work of musical scholarship and one which is of vital interest to all students of keyboard music of the 16th and early 17th centuries.

The collection of keyboard music which naturally provides the basis for this study is the Fitzwilliam Virginal Book, and detailed treatment, copiously illustrated with music examples, is given to the various figures—melodic, rhythmic, and harmonic—in this music and to the forms and styles cultivated by composers for the Virginal. Originally published in England in 1915, this book remains the only thorough study of its type, illuminating a most important branch of English and European music.

HISTORY OF RUSSIAN MUSIC By M. MONTAGU-NATHAN Being an Account of the Rise and Progress of the Russian School of Composers. With a Survey of their Lives and a Description of their Works. Frontispiece. 2nd Edition, Revised. Thick crown 8vo, cloth, 15s. *net.*

Mr. Montagu-Nathan's book breaks new ground; it introduces the English reader to a number of composers, many of whom until recently were nothing more than names.

IRISH MUSICAL HISTORY, Introductory Sketch of, by W. H. GRATTAN FLOOD. A compact Record of the Progress of Music in Ireland during 1,000 Years. Portraits. Crown 8vo, cloth, 5s. 6d. *net* (paper 3s. *net*).

RISE AND DEVELOPMENT OF OPERA. Embracing a Comparative View of the Art in Italy, Germany, France and England. By JOSEPH GODDARD. Showing the Cause of the Falling Back of the English School in the Modern Period, and the Compensation which that Involved. Numerous Musical Examples, Portraits and Facsimiles. Crown 8vo, cloth, 12s. 6d. *net.*

RISE AND DEVELOPMENT OF MILITARY MUSIC. By DR. H. G. FARMER. With Illustrations of Early Instruments and Musical Examples, and Short Biographical Notices of all the Staff Bandmasters. Preface by LIEUT. A. WILLIAMS, *M.V.O., Mus.Doc., Bandmaster of Grenadier Guards.* Crown 8vo, cloth, 15s. *net.*

CATECHISM OF MUSICAL HISTORY AND BIOGRAPHY. By F. J. CROWEST. Revised and Enlarged Edition. Tenth Thousand. 187 pages. Post 8vo, cloth, 5s. *net* (paper, 2s. 6d. *net*).

THE TROUBADOUR AS MUSICIAN, Past and Present. By C. A. HARRIS. Cloth, 5s. *net* (paper, 2s. 6d. *net*).

POLISH MUSIC AND CHOPIN, ITS LAUREATE. A Historical Account from 995 to the Present Time, including Chopin and his Works. By E. RAYSON. Four Portraits. Square 8vo, cloth, 5s. *net* (paper, 3s. 6d. *net*).

NATIONAL MUSIC OF THE WORLD. By H. F. CHORLEY. Edited by H. G. HEWLETT. Many Music Examples. New Issue, with Index added. Crown 8vo, cloth, 10s. 6d. *net*.

Treats of the national tunes, folk-songs and airs of various races of the world. The chapters are undoubtedly marked in a high degree with the critic's acumen, attesting the wide range of Chorley's learning.

CHRONOMETRICAL CHART OF MUSICAL HISTORY. Presenting a Bird's Eye View from the Pre-Christian Era to the XXth Century. By C. A. HARRIS, *A.R.C.O.*, etc. On linen, folded in case, 5s. *net* (on special paper, 2s. 6d. *net*).

HISTORICAL FACTS FOR THE ARABIAN MUSICAL INFLUENCE ON MUSICAL THEORY. By HENRY GEORGE FARMER, *M.A.*, *Ph.D.* Thick crown 8vo, cloth, 30s. net.

Dr. Farmer's researches into the MUSIC OF THE ARABS OF THE MIDDLE AGES, a period when these people led the world's culture, have universal recognition. He now throws a flood of fresh light on many obscure corners in the History of Mediæval Music.

The present work undoubtedly breaks fresh ground in history, and is from the hands of a scholar.

THE PAST AND THE FUTURE. An Inaugural Lecture at Gresham College. By SIR F. BRIDGE, *Mus.Doc.* Crown 8vo, sewed, 1s. *net*.

THE WORLD'S EARLIEST MUSIC. Traced to its Beginnings in Ancient Lands. By collected Evidences of Relics, Records, History and Musical Instruments, from Greece, Etruria, Egypt, China, through Assyria and Babylonia to the Primitive Home, the Land of Akkad and Sumer. By HERMANN SMITH. With sixty-five full-page Illustrations and Cuts, nearly 400 pages. Crown 8vo, cloth, 21s. *net*.

THE GROWTH AND DEVELOPMENT OF MUSIC. Chapters on the Study of Musical History. By EDWARD DICKINSON. With Annotated Guide to Music Literature. Over 400 pages. Thick 8vo, cloth, 18s. 6d. *net*.

ERNES NEWMAN writes: ". . . the extent and the accuracy of the information conveyed make the book indispensable to *students* and to *public libraries*."

GENERAL HISTORY OF MUSIC from the Infancy of the Greek Drama to the Present. By W. S. ROCKSTRO. Fourth Edition, 535 pages. Thick 8vo, cloth, 21s. *net*.

TREATISE ON BYZANTINE MUSIC. By S. G. HATHERLEY. 208 Musical Examples. 162 pages, 4to, cloth, 25s. *net*.

There are upwards of 50 unabbreviated musical pieces, ancient and modern, from Greek, Russian, Turkish and Egyptian sources, given and fully analysed.

ORCHESTRAL.

THE CHAMBER AND ORCHESTRAL WORKS OF JOHANNES BRAHMS. FIRST SERIES TO OP. 67. Historical, Descriptive and Analytical Account of each Work treated in the order of the Opus number, and preceded by a Didactic Section. With Exhaustive Structural, Thematic and Rhythmical Analyses, and a complete Rhythmical Chart of each Movement. By EDWIN EVANS, Senior. With 435 music examples and tables. 8vo, cloth, 30s. *net*.

THE CHAMBER AND ORCHESTRAL WORKS OF JOHANNES BRAHMS. SECOND SERIES, OP. 68 TO THE END. By EDWIN EVANS, Senior. Uniform with the above. With 633 music examples and tables. 8vo, cloth, 30s. *net*.

The above two volumes are a complete technical account of the chamber and orchestral music, with the exception of the two piano concertos. They form a part of the Historical, Descriptive and Analytical Account of the Entire Works of Brahms advertised on page 2.

ORCHESTRAL AND BAND INSTRUMENTS. A Short Account of the Instruments used in the Orchestra, and in Brass and Military Bands. By G. F. BROADHEAD, Mus.B. Dunelm, L.Mus.T.C.L. With 24 Illustrative Music Examples. 8vo, cloth, 5s. *net* (paper, 3s. *net*).

CONCISE METHOD OF INSTRUMENTATION. How to Write for the Orchestra and Arrange an Orchestral or Band Score. Illustrated with Musical Examples and various large folding Charts and Index. By EDWIN EVANS, *Senior, author of* "Beethoven's Nine Symphonies Fully Described and Analysed," etc. 8vo, cloth. Vol. I, 10s. net; Vol. II, 10s. net; Vol. I. How to Write for Strings, Arrangement of Scoring and Preparation of Parts. With Charts. Vol. II. How to Write for Wood, Brass and Drums, and Arrange a Band Score. With large folding Charts.

INSTRUMENTS AND ART OF THE ORCHESTRA. An Introductory Study. With Table showing Range of each Instrument. By P. W. DE COURCY-SMALE, *Mus.Bac.* Cloth, 6s. *net*

ORCHESTRAL WIND INSTRUMENTS, Ancient and Modern Being an Account of the Origin and Evolution of Wind Instruments from the Earliest to the most Recent Times. Illustrated with Plates specially prepared for this Work, giving sixty-one Examples of Instruments (or parts) described. By ULRIC DAUBENY. Important original work, fully illustrated with beautiful Reproductions taken from fine Photographs of the Actual Instruments. 8vo, cloth, 21s. *net*.

HANDBOOK ON THE TECHNIQUE OF CONDUCTING. By SIR ADRIAN BOULT. Seventh Edition, revised. 5s. *net*.

PRACTICAL GUIDE FOR THE CONDUCTOR and Useful Notes for the Orchestra. By F. W. DE MASSI-HARDMAN. With Music Examples and Diagrams. 3s. *net*.

ART OF THE CONDUCTOR. A Suggestive Guide to the Theory and Practice. With 41 Diagrams and Examples. By HECTOR BERLIOZ. Translated by J. BROADHOUSE. Cloth, 7s. 6d. net, paper 4s. net.

A MUSICAL ZOO. Twenty-four Illustrations displaying the Ornamental Application of Animal Forms to Musical Instruments (Violins, Viol da Gambas, Guitars, Pochette, Serpent, etc.). Drawn from the Carved Examples by HENRY SAINT-GEORGE. Cloth, 6s. *net* (paper, 3s. 6d. *net*).

THE FUTURE OF MUSIC. Coming Changes Outlined in Regard to Composer, Conductor and Orchestra. By LOUIS LALOY. Translated by MRS. FRANZ LIEBICH. 8vo, cloth, 3s. 6d. *net* (paper, 2s. *net*).

HOW TO PLAY FROM SCORE. Treatise on Accompaniment from Score on the Organ or Piano. By F. FETIS. Translated by A. WHITTINGHAM. With forty pages of Examples. Crown 8vo, cloth, 7s. 6d. *net*.

This popular and useful book might have been entitled "The Art of Making Arrangements for the Organ or Pianoforte from Full Orchestral and Other Scores." It contains all that is necessary to know upon this subject.

ON CONDUCTING. By RICHARD WAGNER. Translated by E. DANNREUTHER. Fourth Edition. Crown 8vo, cloth, 7s. 6d. *net*.

WEINGARTNER, speaking of this celebrated work, said: "Wagner's book laid the foundation for a new understanding of the function of the conductor, in whom we now recognise, not only the eternal factor that holds together an orchestral, choral or operatic performance, but above all the spiritualising internal factor that gives the performance its very soul."

Grove's Dictionary says: "One of the finest of his minor publications, and to a professional musician perhaps the most instructive. A Treatise on *Style*, giving his views as to the true way of rendering classical music, with minute directions how to do it and how not to do it, together with many examples in musical type from the instrumental works of Beethoven, Weber, Mozart, etc."

NOTES ON CONDUCTING AND CONDUCTORS. By T. R. CROGER, *F.R.G.S.*, *F.Z.S.*, also the Organising and Conducting of Amateur Orchestras, with three full-page Illustrations of the various "Beats" and Plan of the Orchestra. Fifth Impression, Revised and Enlarged. Crown 8vo, cloth, 6s. *net* (paper, 3s. *net*).

ABOUT CONDUCTING. Practical Advice on Concerts, Rehearsals, the Orchestra, Players, Scores and Parts, etc. by SIR HENRY WOOD (Conductor and Organiser of the Promenade Concerts). With two plans, crown 8vo, cloth, 5s. 6d. *net*.

ORGAN.

TECHNICS OF THE ORGAN. An Illuminative Treatise on many Points and Difficulties connected therewith. Special Treatment of Rhythm, Minimisation of the Use of Accessories, Extemporisation, Expressive Regulation of Organ Tone and Accompaniment. By EDWIN EVANS, Senior, F.R.C.O. With over 100 Music Examples. 4to, cloth, 12s. 6d. *net*.

A valuable Book to help a Moderate Player to become a Master.

NEW ORGAN PRINCIPLES AND THEIR INTERPRETATION. A Guide to and Suggestions on Phrasing and Registration with a view to improved Organ Playing. By TERENCE WHITE. With 54 music examples. Octavo, cloth, 6s. *net* (paper covers, 3s. 6d. *net*).

ORGAN OF THE ANCIENTS FROM EASTERN SOURCES (Hebrew, Syriac and Arabic). By HENRY GEORGE FARMER, M.A., Ph.D., Carnegie Research Fellow. Foreword by CANON F. W. GALPIN. With numerous Illustrations. 8vo, cloth, 30s. net.

This, his latest work, yet further enhances the world-wide reputation that Dr. Farmer's studies in Arabian music have already won for him. Important details in the history of the organ hitherto unknown are revealed in these translations from Hebrew, Syriac and Arabic treatises.

"An authoritative treatment of the subject."—*Grove's Dictionary.*

TECHNICS OF ORGAN TEACHING. A Handbook which treats of Special Points in Organ Teaching Examinations, together with Test Questions. By R. A. JEVONS. Boards, 3s. 6d. net.

ART OF ORGAN ACCOMPANIMENT IN THE CHURCH SERVICES. What to Do and what to Avoid: being a Guide to the Organist in the effective rendering of the Music. By WALTER L. TWINNING, *F.R.C.O.*, author of "Examination Test Questions," etc. Cloth, 6s. *net*

MODERN ORGAN BUILDING. Being a Practical Explanation and Description of the Whole Art of Organ Construction, with Especial Regard to Pneumatic Action. Together with Chapters on Tuning, Voicing, etc. By WALTER and THOMAS LEWIS *(Organ Builders).* **Third edition**, with additional matter and Diagrams added, covering the latest developments in electrical control, unit chest, etc., and organ blowing. 116 illustrations, including 76 drawn to scale and reproduced from actual working drawings, together with diagrams, tables, etc. xxix, 247 pages, 4to, cloth, 35s. net.

THE ORGAN AS VIEWED FROM WITHIN. A Practical Handbook on the Mechanism of the Organ. By JOHN BROADHOUSE. With over fifty Illustrations. Second Impression. Crown 8vo, cloth, 15s. net.

THE PEDAL ORGAN. Its History, Design and Control. By Thomas Casson. With folding Diagram. Second Impression. 8vo, cloth, 6s. *net.*

THE EARLY ENGLISH ORGAN BUILDERS and their Works, from the Fifteenth Century to the Period of the Great Rebellion. An Unwritten Chapter on the History of the Organ. By Dr. E. F. Rimbault. Well printed, with Woodcuts. Post 8vo, cloth, 7s. 6d. *net.*

THE ORGAN: A Comprehensive Treatise on its Structure, Capabilities, History and Bibliography. With Criticisms and Depositories, preceded by an Analytical Consideration of general Bibliographical and Catalogual Construction. By J. W. Warman, *late Organist of the Anglican Cathedral, Quebec.* Four parts [A to Nou. (the rest unprinted)], 15s. *net.*

The parts advertised above are all that have been published, at the untimely death of Mr. Warman prevented the completion of the work. The book is a mine of information for those interested in organ subjects. The author devoted the best part of his life in compiling the work and collecting material for his subject.

SOME CONTINENTAL ORGANS (Ancient and Modern) and their Makers. With Specifications of many of the fine Examples in Germany and Switzerland. By James I. Wedgewood. Post 8vo, cloth, 6s. 6d. *net.*

Contains specification and a brief *critique* of some of the famous old Continental organs. Describes also several up-to-date Continental organs. Amongst others particulars are given of those at Haarlem, Cologne, Aix-la-Chapelle, Frankfort, Heidelberg, Ulm, Stuttgart, Einsiedein, Strassburg and Antwerp. This work forms a valuable supplement to Hopkins's and Rimbault's great treatise.

MODERN ORGAN TUNING, The How and Why, Clearly Explaining the Nature of the Organ Pipe and the System of Equal Temperament, together with an Historic Record of the Evolution of the Diatonic Scale from the Greek Tetrachord. By Hermann Smith. Crown 8vo, cloth, 10s. *net.*

THE TEMPLE EDITION OF ORGAN OVERTURES AND ARRANGEMENTS, all with Ped. Obb. 3s. *net* each.

See page 25 for list of about sixty works in this series, including works by Wagner, Tchaïkovsky, Beethoven, Mozart, Handel, Berlioz, Glinka, Schubert, Gounod, Hérold, Mendelssohn, Meyerbeer, Balfe, Auber, Rossini, Weber, Wallace, Suppé, Adam, Thomas, Nicolai, Sterndale-Bennett, Cornelius and Flotow, chiefly arranged by Edwin Evans.

THE INFLUENCE OF THE ORGAN IN HISTORY. By Dudley Buck. Fresh issue with Illustrations. Crown 8vo, cloth, 4s. *net* (or paper, 2s. *net*).

ORGANIST'S REPERTOIRE GUIDE. An International Repertoire Guide (Historical, Educational and Descriptive) to Foreign, British and American Works. By HERBERT WESTERBY, B.B.C. Organ Recitalist (*author of* "Liszt, Composer, and his Piano Works"). 4to, cloth, £1 1s. *net.*

Describes the best Organ Music of foreign countries as well as of Britain and America.

A large and beautifully presented quarto work, fully illustrated by thirty-six plates on fine art paper, comprising seven English and sixteen foreign organs, thirty-one portaits, and illustrations of the houses of Bach and Handel.

REFORM IN ORGAN BUILDING. By THOMAS CASSON. Crown 8vo, sewed, 2s. 6d. *net.*

THE BYRD ORGAN BOOK, for Piano or Organ. A Collection of 21 Pieces (Pavans, Galliards, etc.), by William Byrd, 1543-1623, edited from the Virginal MSS., and now first published in Modern Notation. By M. H. GLYN, 7s. 6d.

ADVICE TO YOUNG ORGANISTS. By J. T. FIELD. 6d. *net.*

THE ORGAN FIFTY YEARS HENCE. A Study of its Development in the Light of its Past History and Present Tendencies. By FRANCIS BURGESS, *F.S.A., Scot.* 8vo, 2s. *net.*

THE TEMPLE EDITION OF ORGAN OVERTURES. (3 Staves).

Arranged from Full Score by Edwin Evans, Senr. (except where otherwise stated).

Price 3/- *net* each.

ATHALIE (Mendelssohn).
BARBER OF BAGDAD (Peter Cornelius).
BEATRICE AND BENEDICT (Berlioz).
BENVENUTO CELLINI (Berlioz).
BOHEMIAN GIRL (Balfe).
CALM SEA AND PROSPEROUS VOYAGE (Mendelssohn).
CARNAVAL ROMAIN (Berlioz).
CORSAIR (Berlioz).
CROWN DIAMONDS (Auber).
EGMONT (Beethoven).
EURYANTHE (Weber).
FAUST (Gounod).
FAUST (Wagner).
FESTIVAL OVERTURE (Tschaikowsky).
FIGARO (Mozart).
FINALE (Rubinstein's Sonata, Op. 12).
FLYING DUTCHMAN (Wagner).
FRA DIAVOLO (Auber).
FREISCHUTZ (Weber). A. Whittingham.
ISABELLA (Suppé).
ITALIANA (Rossini).
KING LEAR (Berlioz).
KING STEPHEN (Beethoven). P. J. Mansfield
LA CLEMENZA DI TITO (Mozart). P. J. Mansfield.
L'AFRICAINE (Meyerbeer).
LA REINE DE SABA (Gounod)
LARGO from Beethoven's Sonata in E flat. W. A. C. Cruikshank.
LE SONGE D'UNE NUIT D'ETE (Thomas).
LIFE FOR THE CZAR (Glinka).
LIGHT CAVALRY (Suppé).
LOHENGRIN (Wagner).
LURLINE (Wallace).
MAGIC FLUTE (Mozart).
MARITANA (Wallace).
MASANIELLO (Auber).
MEISTERSINGERS (Wagner).
MERRY WIVES OF WINDSOR (Nicolai).
MIDSUMMER NIGHT'S DREAM (Mendelssohn).
MIGNON (A. Thomas).
NAIADES, THE (Sterndale Bennett)
OBERON (Weber). A. Whittingham
OTHO (Handel). W. A. C. Cruikshank.
1812 OVERTURE (Tschaikowsky).
POET AND PEASANT (Suppé).
PARSIFAL (Wagner).
RAYMOND (Thomas).
RIENZI (Wagner).
ROSAMUNDE (Schubert).
RUY BLAS (Mendelssohn).
SCIPIO (Handel).
SEMIRAMIDE (Rossini).
SI J'ETAIS ROI (Adam).
SIRENE, LA (Auber).
SON AND STRANGER (Mendelssohn). W. A. C. Cruikshank.
STRADELLA (Flotow).
TANCREDI (Rossini).
TANNHAUSER (Wagner).
TRISTAN AND ISOLDA (Wagner).
WAVERLEY (Berlioz).
WILLIAM TELL (Rossini). A. Whittingham.
ZAMPA (Hérold).

PIANO SOLO OVERTURES.

Price 2/- *net* each.

BOHEMIAN GIRL (Balfe).
***CALIPH OF BAGDAD** (Boieldieu).
CROWN DIAMONDS (Auber).
DER FREYSCHUTZ (Weber).
DON GIOVANNI (Mozart).
DONNA DEL LAGO (Rossini).
FRA DIAVOLO (Auber).
GUY MANNERING (Sir H. R. Bishop).
IDOMENEO (Mozart).
IL BARBIERE (Rossini).
***IL TANCREDI** (Rossini).
LIGHT CAVALRY (Suppé).
MAGIC FLUTE (Zauberflöte), (Mozart).
MARITANA (Wallace).
MASANIELLO (Auber).
***MERRY WIVES OF WINDSOR** (Nicolai).
MIGNON OVERTURE (A. Thomas)
NOZZE DE FIGARO (Mozart).
***POET AND PEASANT** (Suppé).
RAYMOND (Thomas).
SEMIRAMIDE (Rossini).
WILLIAM TELL (Rossini).
***ZAMPA** (Hérold).

* Also arranged as Duet (piano, 4 hands), price 2/6 *net*.

PIANOFORTE.

THE PIANO WORKS OF BRAHMS. By EDWIN EVANS, *Senior*. Historical, Descriptive and Analytical Account of each Work treated in the Order of the Opus number, and preceded by a Didactic Section. 8vo, cloth, 30s. *net*.

The above volume is a complete technical account of the piano works. It forms a part of the Historical, Descriptive and Analytical Account of the Entire Works of Brahms advertised on page 2.

HOW TO PLAY BACH'S 48 PRELUDES AND FUGUES. A Guide Book for the use of Piano Students as an aid to the Unravelling and Interpretation of these Masterpieces, ensuring a more Intelligent Keyboard Rendering. By C. W. WILKINSON. Crown 8vo, cloth, 10s. *net*.

NATURAL TECHNICS IN PIANO MASTERY. A Complete and authoritative Manual, covering every Phase of Piano Playing and Study—tracing in simple Steps for the Student's Guidance the aesthetic Steps as well as the technical Problems leading from Beginning Stages to Concert Artistry. By JACOB EISENBERG. 55 illustrations. Crown 8vo, cloth, 12s. 6d. *net*.

THE APPROACH TO LISZT. A Course of Modern Tonal-Technique for the Piano, in the form of Graded Studies from the Moderately Difficult to the Master Stage. By HERBERT WESTERBY, *Mus.Bac. Lond., F.R.C.O., etc.* Folio, 5s. 6d. *net*.

Preliminary Studies in Touch and Phrasing in all Keys. Based on the Scales and Broken Chords.

Intermediate Studies in Sequential, Wrist and Preparatory Arpeggio Work in the Black and White Key Positions.

Advanced Sequential Studies on the Black Keys, with Sixteen Excerpts from Liszt's Piano Works. The Master Works: Fifty-eight Excerpts from Liszt.

THE ART OF TUNING THE PIANOFORTE. A New Comprehensive Treatise to enable the Musician to Tune his Piano upon the System founded on the Theory of Equal Temperament. By HERMANN SMITH. New Edition, thoroughly Revised. Crown 8vo, limp cloth, 6s. *net*.

ESSENTIALS IN PIANO-PLAYING, and other Musical Studies. By J. ALFRED JOHNSTONE, Hon. L.Mus., T.C.L. Portrait, 243 pages. Crown 8vo, cloth, 10s. *net*.

EXTEMPORISING AT THE PIANO MADE EASY. A Manual for Beginners in Musical Composition. Hints and Aids for the "From Brain to Keyboard" Composer. By REV. E. H. MELLING, *F.R.C.O.* 8vo, limp cloth, 3s. 6d. *net* (paper 2s. *net*).

INDIVIDUALITY IN PIANO TOUCH. By ALGERNON H. LINDO and J. ALFRED JOHNSTONE. Crown 8vo, 2s. 6d. *net.*

THE ARTIST AT THE PIANO. Essays on the Art of Musical Interpretation. By GEORGE WOODHOUSE. New and Revised Edition. Portrait of Paderewski. 8vo, cloth, 5s. 6d. *net.*

The celebrated pianist, Paderewski, after reading the manuscript of this stimulating volume, wrote: "The booklet is quite a remarkable work and a really valuable contribution to the philosophy of pianistic art."

THE STUDENT'S GUIDE TO THE ART OF TEACHING THE PIANOFORTE. By CYRIL R. H. HORROCKS, L.R.A.M., L.T.C.L., A.R.C.M. With an Extensive and Carefully Graded List of Studies and Course of the Great Masters. Numerous Musical Examples. Second edition, Revised. Crown 8vo, cloth, 10s. *net.*

Until quite recently it was thought impossible to give practical instructions on the art of teaching, but the error of this idea has been proved by the great success of the teachers' class at the various musical institutions. The author's aim is to supply a guide-book expressly for beginners and those with limited experience in the art.

PIANOFORTE TEACHER'S GUIDE. By L. PLAIDY. Translated by FANNY RAYMOND RITTER. Crown 8vo, boards, 3s. *net* (paper, 2s. *net*).

CANDIDATE'S SCALE AND ARPEGGIO TESTS for the Piano. In the Primary, Elementary and Junior Grades of all Local Examinations in Music, and the Higher and Lower Divisions of the Associated Board of the R.A.M. and R.C.M. By WILSON MANHIRE. 1s. *net.*

TECHNICAL STUDY IN THE ART OF PIANOFORTE PLAYING (Deppe's Principles). By C. A. EHRENFECHTER. With numerous Illustrations. Fourth Edition. Crown 8vo, cloth, 6s. *net.*

CONTENTS: Position—Arm—Wrist—Fingers; Touch (Tone Production); Legato; Equality of Tone; Tension and Contraction; Five Finger Exercises; Skips; The Scale; Arpeggio Chords; Firm Chords; High Raising of the Arm; Melody and its Accompaniment; Connection of Firm Chords; The Tremolo; The Shake (Trill); The Pedal; Fingering.

HOW TO ACCOMPANY AT THE PIANO. By EDWIN EVANS. (Plain Accompaniment, Figurated Accompaniment, Practical Harmony for Accompanists). 172 Music Examples which are made Clear by the Explanatory Text. Crown 8vo, cloth, 7s. 6d. net.

GRADUATED SCALE AND ARPEGGIO MANUAL. Compiled for the various Exams. By HENRY SAINT-GEORGE. 3s. *net.*

A SYSTEM OF STUDY OF SCALES AND CHORDS. Being Chapters on the Elements of Pianoforte Technique. By B. VINE WESTBROOK, F.R.C.O. Numerous Examples. New and Revised edition. 8vo, 3s. *net.*

The author outlines a scheme which abolishes the drudgery and inspires the pupil with an enthusiasm for practice and formulates a method or system in which that practice may be carried out.

PIANO CLASSES IN ELEMENTARY SCHOOLS. By AUDREY KING. With Music Examples. Crown 8vo, 1s. *net.*

HOW TO PLAY 110 FAVOURITE PIANO SOLOS. Being the 4 Series complete in 1 vol. of "Well-Known Piano Solos: How to Play them with Understanding, Expression and Effect." By CHARLES W. WILKINSON. Crown 8vo, cloth, 12s. 6d. *net.*

WELL-KNOWN PIANO SOLOS. How to Play them with Understanding, Expression and Effect. By C. W. WILKINSON. Four Series, 2s. each (each series containing about 26 articles), or four in one vol. as above.

Contents of the First Series:—SINDING, Rustle of Spring. SCARLATTI, Pastorale le Capriccio. PADEREWSKI, Minuet in G. HANDEL, Harmonious Blacksmith. RUBENSTEIN, Melody in F. SCHARWENKA, Polish Dance. SCHUMANN, Nachtstücke. GODARD, Mazurka. DELIBES, Pizzicati from Sylvia. GRIEG, Wedding Day at Troldhangen. ELGAR, Salut d'Amour. PADEREWSKI, Melodie. RAFF, La Fileuse. TCHAIKOVSKY, Troika. GODARD, Berger et Bergères. CHAMINADE, Pierrette. MOSZKOWSKI, Etincelles. PADEREWSKI, Minuet in A major. GRIEG, Norwegian Bridal Procession. LISZT, Regata Veneziana. CHAMINADE, Automne. MOSKOWSKI, Serenata. LACK, Valse Arabesque. SCHUMANN, Arabeske. CHOPIN, Etude in G flat. DURAND, First Valse.

Draws one's attention to the beauties in a piece, explains difficulties here and there, draws attention to a pedal effect and any peculiarity of fingering, and generally gives all the information a professor is expected to give to his pupils.

DELIVERY IN THE ART OF PIANOFORTE PLAYING, On Rhythm, Measure, Phrasing, Tempo. By C. A. EHRENFECHTER. Second Edition. Crown 8vo, cloth, 6s. *net.*

PIANO TOUCH, PHRASING AND INTERPRETATION. By J. Alfred Johnstone. Crown 8vo, cloth, 6s. net.

PRACTICE REGISTER for Pupil's Daily Practice. A Specimen, 1d. (or 2s. 6d. per 100).

REEVES' VAMPING TUTOR. Art of Extemporaneous Accompaniment, or Playing by Ear on the Pianoforte, Rapidly Enabling anyone having an Ear for Music (with or without any Knowledge of Musical Notation) to Accompany with Equal Facility in any Key. Practical Examples. By FRANCIS TAYLOR. New Edition, to which is added Instructions for Accompaniment with Equal Facility in every Key illustrated by Examples. Folio, 2s. *net.*

THE DEPPE FINGER EXERCISES for Rapidly Developing an Artistic Touch in Pianoforte Playing, Carefully Arranged, Classified and Explained by AMY FAY (Pupil of Tausig, Kullak, Liszt and Deppe). Folio, English or Continental Fingering, 2s. *net.*

INTRODUCTION TO RUSSIAN PIANO MUSIC. By HERBERT WESTERBY, Mus.Bac.Lond., F.R.C.O., L.Mus.T.C.L., 1s. *net.*

REEVES' POPULAR PIANOFORTE TUTOR. Rudiments of Music, Exercises with Popular Airs, Major and Minor Scales. With Illustration of Fingerboard. Folio, 2s. 6d. *net.*

TECHNICAL AND THEORETICAL.

ESSENTIALS IN MUSIC STUDY FOR EXAMINATIONS. A Helpful Guide both for the General Student and Candidates for Junior and Intermediate Examinations. By Rev. E. H. Melling, F.R.C.O. Cloth, 5s. *net* (paper covers, 2s. 6d. *net*).

Rev. E. H. Melling is the author of several popular works which have been found of great use to music students—"Guide for the Young Composer," "Extemporising at the Piano made Easy," etc.

GUIDE FOR THE YOUNG COMPOSER. Hints on the Art of Composition, with Examples of Easy Application. By Rev. E. H. Melling, F.R.C.O. Cloth, 5s. *net* (paper covers, 2s. 6d. *net*).

EXAMINATION TEST QUESTIONS. Containing spaces for the Pupils' Written Answers. By Walter L. Twining, F.R.C.O. No. 1, Musical Notation and Time; No. 2, Formation of Scales; No. 3, Ornaments; No. 4, Intervals, 9d. *net* each.

THEORY OF MUSIC FOR YOUNG MUSICIANS. With Answers given to all the Questions, and a Dictionary of necessary Musical Terms. By Mary Sharp. 1s. 6d. net

102 TEST QUESTIONS ON THE GENERAL RUDIMENTS OF MUSIC. In Groups of Six each Lesson, for Written or Oral Use. By Wilson Manhire, L.R.A.M. 6d. *net*.

PRIMARY COURSE IN THE RUDIMENTS OF MUSIC, With Hints on Answering Questions (Written Work) for All Examinations in the Primary, Elementary and Preparatory Grades. By Wilson Manhire, L.R.A.M., etc. 2s. *net*.

EXAMINATION CANDIDATE'S GUIDE to Scale and Arpeggio Piano Playing (with Tests). All that is required for the Various Exams. By Wilson Manhire, L.R.A.M. 3s. *net*.

CANDIDATE'S SCALE AND ARPEGGIO TESTS for the Piano. By Wilson Manhire, L.R.A.M. 1s. *net*.

STUDIES IN MODULATION for Practical and Theoretical Purposes. By Percy Baker, F.R.C.O., etc. 3s. net.

MUSICAL FORM, A Handbook to, for Instrumental Players and Vocalists. By E. van der Straeten. With Musical Examples, 205 pages. 8vo, cloth, 6s. 6d. *net* (paper 4s. *net*).

The part of the work on Dance Forms gives a history and description of the Suite or Partita, Allemande, Courante, Sarabande, Gigue, Gavotte, Musette, Bourrée, Branle, Passepied, Rigaudon, Loure, Pavane, Galliard, Tambourin, Cebell, Rondo, Menuet, Polonaise, Mazurka, Bolero, Tarantella, Saltarello, March, Ciaccone and Passacaglia.

STUDIES IN HISTORICAL FACTS AND MUSICAL FORM. Being a Guide and Note Book for a more Systematic Preparation of the General Knowledge Papers now set at the Universities and Colleges of Music. By PERCY BAKER. Cloth, 5s. 6d. *net* (paper, 3s. *net*).

MOZART AND THE SONATA FORM. By J. R. TOBIN, Mus.B. *See Pianoforte Section.*

MUSICAL EXPRESSIONS, PHRASES AND SENTENCES, with their Corresponding Equivalents in French, German and Italian. By F. BERGER. 8vo, cloth, 5s. 6d. *net* (paper, 3s. *net*).

RUDIMENTS OF MUSIC, Set forth in Graded QUESTIONS with ANSWERS, for Use of Candidates preparing for the Examinations of R.A.M., R.C.M. and T.C.L. By B. HOWARTH, L.R.A.M. and A.R C.M. Crown 8vo, 2s. *net.*

The Answers are always on the right hand page and can be covered over if desired, the Questions being on the corresponding left hand pages.

ELEMENTARY LESSONS ON SIGHT-SINGING. Combining the Staff and Tonic Sol-fa Notations. With Music Examples throughout. By J. W. ROSSINGTON, L.R.A.M. Cloth, 3s. 6d. *net*; paper, 2s. *net.*

For many singers there is only one method of becoming good sight-readers, viz., combining the tonic sol-fa with the staff notation. It is hoped that a perusal of these elementary lessons will show the principles on which this combination is effected, and simplify the somewhat difficult tasks of sight-reading.

STEPS IN HARMONY. With Copious Explanatory Examples and Graded Test Exercises. A Handbook for Students. By DR CHURCHILL SIBLEY. With Music Examples throughout. Crown 8vo, boards, cloth back, 6s. *net*

It is believed that he who thoroughly masters the contents of these pages will be prepared to study intelligently the harmonic structure of the works of the great masters, and also to follow critically the changeful tendencies of the present day.

600 QUESTIONS AND 600 EXERCISES IN ELEMENTARY MUSICAL THEORY. By W. H. PALMER. Crown 8vo, 3s. net.

Intended as a help to the private student and to the candidate preparing for the several musical examinations.

THE MODAL ACCOMPANIMENT OF PLAIN CHANT. A Practical Treatise. By EDWIN EVANS, Senior, F.R.C.O. Part I, Theoretical; Part II, Practical School of Plain Chant Accompaniment, consisting of 240 Exercises, with an Appendix of Notes. Crown 8vo, cloth, 8s. 6d. *net.*

THE HARMONISING OF MELODIES. A Text-Book for Students and Beginners. By H. C. Banister. Third Edition, with numerous Musical Examples. Crown 8vo, limp cloth, 5s. *net.*

MUSICAL ANALYSIS. A Handbook for Students. By H. C. Banister. With Musical Illustrations. Crown 8vo, limp cloth, 5s. *net* (paper covers, 2s. 6d. *net*).

THE ART OF MODULATING. A Series of Papers on Modulating at the Pianoforte. By Henry C. Banister. With 62 Musical Examples. Crown 8vo, cloth, 6s. *net* (paper covers, 3s. 6d. *net*).

MODERN CHORDS EXPLAINED. (The Tonal Scale in Harmony.) By Arthur G. Potter. Musical Examples from C. Debussy, Richard Strauss and Granville Bantock. 8vo, cloth, 4s. *net* (paper covers, 2s. *net*).

EXERCISES IN FIGURED BASS AND MELODY HARMONIZATION. By James Lyon, Mus.Doc. 4to, 3s. 6d. *net.*

EXAMPLES OF FOUR-PART WRITING FROM FIGURED BASSES AND GIVEN MELODIES. By James Lyon, Mus.Doc. 4to, 5s. 6d. *net.*

These exercises are printed in open score so as to be of use in score reading tests. This volume forms a key to "Exercises in Figured Bass" by the same author (see above).

HOW TO COMPOSE. A Practical Guide to the Composition of all Works within the Lyric Form, and which include the Valse, Gavotte, Mazurka, Polonaise, March, Minuet, and all Ordinary Dance Forms; as also the Nocturne, Impromptu, Berceuse, Reverie and Similar Characteristic Pieces. By Edwin Evans, Senior, F.R.C.O. With 60 Musical Examples. Crown 8vo, cloth, 6s. net.

THE RUDIMENTS OF GREGORIAN MUSIC. By Francis Burgess, F.S.A., Scot. Second Impression. Crown 8vo, limp cloth, 2s. 6d. *net* (paper, 1s. 6d. *net*).

MUSICAL PRONOUNCING DICTIONARY. By Dr. Dudley Buck. Eighth Edition, with the Concise Explanation and Pronunciation of each Term. Edited and Revised by A. Whittingham. Crown 8vo, 1s. 6d. net.

A most valuable and useful little book to all musical people. The method adopted for giving the pronunciation of each term is most concise and clear.

A FIRST BOOK OF MUSIC FOR BEGINNERS, Embodying English and Continental Teaching. By ALFRED WHITTINGHAM. Sixth Thousand. Crown 8vo, sewed, 4d. *net.*

HARMONY, EASILY AND PROGRESSIVELY ARRANGED. Presenting in a Simple Manner the Elementary Ideas as well as the Introduction to the Study of Harmony. With about 300 Musical Examples and Exercises. By PAUL COLBERG. Crown 8vo, cloth, 7s. 6d. *net.*

COMPEND OF MUSICAL KNOWLEDGE. By PERCY BAKER, F.R.C.O., L.Mus. T.C.L. Being a Guide with Notes, Hints and Articles on the Study of Examination Questions. Crown 8vo, cloth, 6s. *net* (paper, 3s. 6d. *net*).

Primarily to help candidates entering for the R.C.O. and T.C.L. Diplomas, though containing much information for the amateur musician and general reader. Indispensable to teachers in guiding their pupils through a course of study dealing with a large number of subjects like those set for the F.R.C.O. and A.R.C.O.

ELEMENTARY MUSIC. A Book for Beginners. By DR. WESTBROOK. With Questions and Vocal Exercises. Fifteenth Thousand. Crown 8vo, cloth, 4s. *net* (paper, 2s. *net*).

CONTENTS: 1. The Staff and its Clefs. 2. Notes and their Rests. 3. Bars and Time. 4. Accidentals. 5. Keys and Scales. 6. Intervals. 7. Musical Pitch. 8. Accent. 9. Secondary Signs. 10. Ornaments and Groups of Notes. 11. Voices and Scores. 12. Church Modes. 13. Italian and other Directions. 14. Foreign Note-Names. 15. Questions. 16. Vocal Exercises.

"His explanations are extremely clear. The questions at the end will be found very useful."—*Musical Times.*

EXERCISES ON GENERAL ELEMENTARY MUSIC. A Book for Beginners. By K. PAIGE. Fourth Edition. Part I, 1s. 6d. *net*; Part II, 2s. *net*. Crown 8vo, paper (2 parts complete in cloth, 5s. *net*).

CONTENTS OF PART I: 1. Pitch. 2. Length of Sounds. 3. Time. 4. Time and Accent. 5. Intervals. 6. Scales. 7. Transposition. 8. Syncopation. 9. Signs and Abbreviations. 10. Notation. 11. Miscellaneous Questions and Exercises.

CONTENTS OF PART II: 1. Triads. 2. First Inversion of a Triad. 3. Second Inversion of a Triad. 4. Dissonances. 5. Suspensions. 6. Sequences. 7. Cadences. 8. Dominant Sevenths, etc.

HOW TO MEMORISE MUSIC. By C. F. KENYON. With numerous Musical Examples. Fourth Edition. Crown 8vo, cloth, 5s. *net.*

HOW TO HARMONIZE MELODIES. With Hints on Writing for Strings and Pianoforte Accompaniments. By J. HENRY BRIDGER, Mus.Bac. With Musical Examples throughout. Crown 8vo, cloth, 6s. *net.*

THE ART OF MODULATION. A Handbook showing at a Glance the Modulations from one Key to any other in the Octave, consisting of 1,008 Modulations. For the Use of Organists and Musical Directors. Edited by CARLI ZOELLER. Third Edition. Roy. 8vo, cloth, 8s. *net* (paper, 5s. *net*).

THE STUDENT'S BOOK OF CHORDS. With an Explanation of their Inversions and Resolutions. By PASCAL NEEDHAM. Crown 8vo, sewed, 1s. 6d. *net*.

The chords with their inversions and resolutions are briefly and clearly explained.

TRANSPOSITION AT SIGHT. For Students of the Organ and Pianoforte. By H. E. NICHOL. Fourth Edition, with numerous Musical Exercises. Crown 8vo, 2s. net.

The practice of transposing upon the lines here laid down develops the "mental ear," quickens the musical perception and gives ease in sight reading; as it is evident that, if the student can *transpose* at sight, he will not have much difficulty in merely *playing* at sight. Free use is made of the tonic sol-fa as well as the standard notation in many musical examples.

SCHUMANN'S RULES AND MAXIMS FOR YOUNG MUSICIANS. Sewed, 6d.

THE STUDENT'S HELMHOLTZ. Musical Acoustics, or the Phenomena of Sound as Connected with Music. By JOHN BROADHOUSE. With more than 100 Illustrations. Fifth Impression. Crown 8vo, cloth, 12s. 6d. *net*.

"In his Preface the author says: 'The object of the present book is to give, in one volume, a good general view of the subject to those who can neither spare time to read, nor money to buy a number of large and expensive works.' A perusal of the book justifies us in asserting that this design is most satisfactorily carried out; and it is not too much to say that although the plan of the work excludes the possibility of minutely dissecting every subject treated upon, any careful reader may obtain so clear an insight into the principle of acoustics, as to enable him not only to pass an examination but to store up a large amount of general knowledge upon the phenomena of sound."—*Musical Times*.

VIOLIN AND STRINGED INSTRUMENTS.

GERMAN VIOLIN MAKERS. By Fridolin Hamma. A Critical Dictionary of German Violin Makers with a Series of Plates Illustrating Characteristic and Fine Examples of their Work. Translated by Walter Stewart. 64 pages of text and 80 plates in half-tone, 12 x 10 inches, cloth, £5 5s. net.

VIOLIN TECHNICS, or How to Become a Violinist. Exact Instructions, Step by Step, for its Accomplishment with or without a Teacher. By "FIRST VIOLIN." 3s. *net.*

PLAYING AT SIGHT FOR VIOLINISTS and Others in an Orchestra. Valuable Hints and Aids for its Mastery. By SYDNEY TWINN. Post 8vo, 3s. *net.*

ADVANCED MODERN VIOLIN TECHNICS.

TONAL SCALES AND ARPEGGIOS FOR VIOLIN. Introductory to the Unusual Intonation and Finger-grouping of Advanced Modern Music. By SYDNEY TWINN. 4to, 3s. *net.*

"These scales will be useful to advanced players who find difficulties in the unusual intonation and technique of modern music."—*Strad.*

SCALES AND ARPEGGIOS. Indispensable Studies for the Violin. Edited by ALBERT GRAFF. 1s. 6d. *net.*

ARPEGGIOS FOR THE VIOLIN. By BASIL ALTHAUS. Folio. 3s. *net.*

VIOLINIST'S ENCYCLOPÆDIC DICTIONARY. Containing the Explanation of about 4,000 Words, Phrases, Signs, References, etc., Foreign, as well as English, used in the Study of the Violin, and also by String Players generally, by F. B. EMERY, M.A. New and enlarged edition, doubled in size. 246 pp., crown 8vo. Cloth 12s. 6d. *net,* or printed on India paper and bound in red pegamoid rounded corners, suitable for student or travel, 15s. *net.*

70 PREPARATORY VIOLIN EXERCISES for Beginners in the First Position, carefully Graduated, Supplementary to the First Instruction Book. By WILSON MANHIRE, L.R.A.M., A.R.C.M., etc. 2s. 6d. *net.*

BOW INSTRUMENTS, their Form and Construction. Practical and Detailed Investigation and Experiments regarding Vibration, Sound Results, and Construction. By J. W. GILTAY. Issued into English by the Author in Co-operation with E. VAN DER STRAETEN. Numerous Diagrams. 8vo, cloth, 16s. *net.*

"A valuable treatise."—*The Strad.*

OLD VIOLINS AND VIOLIN LORE, Famous Makers of Cremona and Brescia, and of England, France and Germany (with Biographical Dictionary), Famous Players, and Chapters on Varnish, Strings and Bows, with 13 full-page plates. By H. R. HAWEIS. Thick crown 8vo, cloth, 25s. *net.*

YOUNG VIOLINIST'S SCALE AND ARPEGGIO MANUAL. By WILSON MANHIRE, L.R.A.M., etc. 2s. *net.*

NOTABLE VIOLIN SOLOS: How to Play Them. Three Series (consisting of 43 descriptive Articles in all). By E. VAN DER STRAETEN. 2s. 6d. *net* each series. Also complete in cloth, with Portraits, 10s. *net.*

VIOLIN MANUFACTURE IN ITALY and its German Origin. By DR. E. SCHEBEK. Translated by W. E. LAWSON. Second Edition. Square 12mo, cloth, 6s. *net*; paper, 3s. 6d. *net.*

CHATS WITH VIOLINISTS. By WALLACE RITCHIE. With four Photographic Illustrations. Crown 8vo, cloth, 8s. 6d. *net.*

CHAPTERS. On the Importance of being Accurate; On Various Details; On the Violin and its Fittings; On Reading from Sight and Playing from Memory; A Few Violin Secrets; Some Valuable Technical Exercises; Hand Development for Violinists, including Eighteen Excellent Finger Gymnastics; Sundry Useful Hints.

I here lay before the public that information and advice which I have hitherto been content to reserve for the sole use of my own pupils. During a considerable experience, both as a student and as a teacher of the violin, I have naturally pieced together quite a variety of small hints and items of information which, though modest enough individually, have been found on the whole to be of no inconsiderable value, not only with regard to my own playing, but also—and which is of far more importance—in enabling me to impart a knowledge of the art to others.

ADVICE TO VIOLIN STUDENTS. Containing Information of the Utmost Value to every Violinist. By Wallace Ritchie. Crown 8vo, cloth, 7s. 6d. net (paper, 5s. *net*).

CONTENTS: Selecting and Adjusting—Choice of a Teacher—Course of Study—The Sevoik Method—Practising—Style—Tone Production—Pronunciation of Terms, Names, etc.—Graded List of Studies, Pieces, etc. Together with Hints on Common Faults—Shifting—Reading Music—Stopping—Harmonics—Vibrato—Tempo—Intonation, Pitch, etc.

INFORMATION FOR PLAYERS, Owners, Dealers and Makers of Bow Instruments, also for String Manufacturers. Taken from Personal Experiences, Studies and Observations. By WILLIAM HEPWORTH. With Illustrations of Stainer and Guarnerius Violins and Gauge of Millimetres and Centimetres, etc. Crown 8vo, cloth, 8s. 6d. *net.*

CONTENTS: The Pegs—Neck—Finger-board—Bridge—Tail-piece—Saddle—Violin Holder—Tail-pin—Bar—Sound-post—On the Stringing of Bow Instruments in General Use—Strings—Rosin—Cleaning of the Instrument and the Bridge—Bow—Violin Case—Repairs—Preservation—Conclusion.

SKETCHES OF GREAT VIOLINISTS AND GREAT PIANISTS. Biographical and Anecdotal, with Account of the Violin and Early Violinists. Viotti, Spohr, Paganini, De Beriot, Ole Bull, Clementi, Moscheles, Schumann (Robert and Clara), Chopin, Thalberg, Gottschalk, Liszt. By G. T. FERRIS. Third Edition. Crown 8vo, cloth, 8s. 6d. *net.*

TREATISE ON THE STRUCTURE AND PRESERVATION OF THE VIOLIN and all other Bow Instruments. Together with an Account of the most Celebrated Makers and of the Genuine Characteristics of their Instruments. By J. A. OTTO, with Additions by J. BISHOP. With Diagrams and Plates. Fourth Edition, further Enlarged. Crown 8vo, cloth, 12s. 6d. net.

Contains instructions for the repair, preservation and bringing out the tone of instruments; tracing model for violin, mutes and fiddle holders; list of classical works for stringed instruments. This work is especially valuable for makers of violins.

HOW TO PLAY THE FIDDLE. For Beginners on the Violin. By H. W. and G. GRESSWELL. Eighth Edition. Crown 8vo, cloth, 6s. *net*; or in 2 vols., paper, 3s. *net.*

BIOGRAPHICAL DICTIONARY OF FIDDLERS. Including Performers on the Violoncello and Double Bass, Past and Present. Containing a Sketch of their Artistic Career, together with Notes of their Compositions. By A. MASON CLARKE. 9 Portraits. Post 8vo, cloth, 10s. *net.*

ART OF HOLDING THE VIOLIN AND BOW AS EXEMPLIFIED BY OLE BULL. His Pose and Method proved to be based on true Anatomical Principles. By A. B. CROSBY, M.D., Professor of Anatomy. Portrait, Diagrams and Illustrations. 8vo, cloth, 6s. *net.*

Included in the above are some interesting recollections and anecdotes of Ole Bull.

THE VIOLIN AND OLD VIOLIN MAKERS. Being a Historical and Biographical Account of the Violin. By A. MASON CLARKE. With Facsimile of Labels used by Old Masters and illustrations of a copy of Gasparo da Salo. Crown 8vo, cloth, 10s. *net.*

THE VIOLIN, ITS HISTORY AND CONSTRUCTION. Illustrated and Described from many Sources. Together with a List of Italian and Tyrolese Makers. With 28 Illustrations and folding Examples of the First Music issued for the Lute, Fiddle and Voice. From the German of ABELE and NIEDERHEITMANN. By J. BROADHOUSE. Fresh issue printed in larger size. Crown 8vo, cloth, 12s. 6d. *net.*

The learned and instructive treatise of Abele, skilfully rendered by J. Broadhouse and supplemented by a version of Niederheitmann's list of Italian and Tyrolese violin makers.

HOW TO MAKE A VIOLIN, Practically Treated. By J. BROADHOUSE. New and Revised Edition. With 47 Illustrations and Folding Plates and many Diagrams, Figures, etc. Crown 8vo, cloth, 10s. 6d. *net.*

CONTENTS: Introduction—The Parts of the Violin—On the Selection of Wood—The Tools required—The Models—The Mould—The Side-pieces and Side Linings—The Back—Of the Belly—The Thickness of the Back and Belly—The Bass Bar—The Purfling—The Neck—The Finger-board—The Nut and String Guard—Varnishing and Polishing—Varnishes and Colouring Matter—The Varnish—A Mathematical Method of Constructing the Outline—The Remaining Accessories of the Violin.

This new edition had the advantage of being revised throughout by a celebrated violin maker.

A MUSICAL ZOO. Twenty-four Illustrations displaying the Ornamental Application of Animal Forms to Musical Instruments (Violins, Viol da Gambas, Guitars, Pochette, Serpent, etc.). Drawn from the Carved Examples by HENRY SAINT-GEORGE. Cloth, 6s. *net* (paper, 3s. 6d. *net*).

THE HISTORY OF THE VIOLIN and other Instruments Played on with the Bow from the Remotest Times to the Present. Also an Account of the Principal Makers. Coloured Frontispiece and numerous Illustrations and Cuts. By W. SANDYS, F.S.A., and S. A. FORSTER. Thick 8vo, cloth, 35s. *net.*

This well-known book by these writers, first published in 1864, is especially valuable in connection with the instrument makers of the English school, and is the chief literary source of information concerning our old native craftsmen. It is good to bear in mind that as Simon Forster was a skilled and experienced instrument worker, the technical notes to be discovered in the pages of this book in which he collaborated are worthy of attention.

THE VIOLIN AND BOW. A Treatise (in Three Languages, English, French and German), with numerous Copies of Photographs taken from Life, supplemented by various Examples and Original Studies by I. B. Poznanski. 5s. *net.*

AN IMPORTANT LESSON TO PERFORMERS ON THE VIOLIN. By the Celebrated TARTINI. Portrait. Being the Translation by Dr. Burney, issued originally in 1779, together with the original Italian. 8vo, cloth, 6s. *net* (paper, 3s. *net*).

VIOLONCELLO EXERCISES, SCALES AND ARPEGGIOS. By E. Gillet. Complete in one vol., 4s. *net*; or Part I, Exercises, 1s. 6d. *net*, Part II, Scales, 1s. 6d. *net*, and Part III, Arpeggios, 1s. 6d. *net.*

ART OF VIOLONCELLO PLAYING. Tutor in Three Books. By E. van der Straeten. Text in English and French. 4to. Book I, 3s. 6d. *net*; Book II, 4s. *net.*

WELL-KNOWN VIOLONCELLO SOLOS. How to Play Them. Three Series. By E. van der Straeten. 2s. 6d. *net*, each series. Also complete in cloth, with Portraits, 10s. *net.*

HOW TO REPAIR VIOLINS and other Musical Instruments. By Alfred F. Common. With Diagrams. Crown 8vo, cloth, 8s. 6d. *net.*

ROYSTON'S PROGRESSIVE VIOLIN TUTOR (with Illustrations giving Correct Position for Hand, Wrist and Fingers). Folio, 3s. *net.*

VOCAL.

SUCCESS IN AMATEUR OPERA. Instructions on Auditions, Equipment of the Society and the Conductor, Allocation of Rôles, Rehearsals, Training of Soloists, Diction, Conducting, etc. By HUBERT BROWN. Including a Section on Stage Management, by H. G. TOY. Preface by DEREK OLDHAM. Crown 8vo, cloth, 6s. net;

SPEECH DISTINCT AND PLEASING, or Why not Learn to Speak Correctly? A clear description of the mental and physical qualities on which the art of good speaking is founded and grounded. By FRANK PHILIP. 162 pages, Crown 8vo, cloth, 7s. *net*; paper covers, 4s. *net*.

VOICE PRODUCTION FOR ELOCUTION AND SINGING. By REV. E. H. MELLING. Music Examples. 31 pages, f'cap 8vo, cloth, 4s. net; paper covers, 2s. net.

THE VOCAL WORKS OF JOHANNES BRAHMS. Historical, Descriptive and Analytical Account of each Work. Original English Translations supplied to many numbers. By EDWIN EVANS, Senior. Thick 8vo, cloth, 35s. *net*.

The above volume is a complete technical account of the vocal works. It forms a part of the Historical, Descriptive and Analytical Account of the Entire Works of Brahms advertised on page 2.

VOCAL TRAINING AND PREPARATION FOR SONG INTERPRETATION. With a Section showing how to Determine Accurately by Pitch and Curve Graphs the special Suitability of Songs selected for particular Vocal Requirements. Music Illustrations and Descriptive Diagrams. By FRANK PHILIP. 8vo, cloth, 15s. *net*.

THE AMATEUR VOCALIST. A Guide to Singing. With Useful Hints on Voice Production, Song Preparation, etc. By WALTER L. TWINNING, F.R.C.O. Post 8vo, limp cloth, 2s. net.

HOW TO TEACH CLASS SINGING, and a Course of Outline Lessons which illustrate the psychological principles upon which successful tuition is based. By GRANVILLE HUMPHREYS, Professor of the Art of Teaching, Voice Production, etc., at the T.S.-F.C.; late Lecturer in Class Singing at the Training School for Music Teachers. Numerous Music Illustrations. Cloth, 10s. *net*.

Teachers will find this very striking book of great value. The publishers have no hesitation in strongly recommending it.

THE VOICE AND SINGING. Practically Explained, Condensed but Comprehensive Treatise, designed principally for Students and Amateurs, by an Experienced Singer and Teacher (C. W. PALMER). Cloth, 5s. *net*; paper, 2s. 6d. *net*.

"I have studied the subject as an enthusiast both theoretically and practically, both as student and teacher, for over thirty years."—*Extract from the Preface.*

VOCAL SUCCESS, or Thinking and Feeling in Speech and Song, including a Chapter on Ideal Breathing for Health. By the Rev. Chas. Gib. Crown 8vo, cloth, 5s. net; or paper covers, 2s. 6d. net.

The known facts of science in connection with both the structure and functions of the vocal organs are stated; and have been supplemented by impressions formed in the course of long experience and experiment in the training of voices.

VOCAL SCIENCE AND ART. Hints on Production of Musical Tone. By Rev. Chas. Gib. The Boy's Voice, Muscular Relaxation, Art of Deep Breathing, Elocution for Ordination Candidates. With Numerous Illustrations, and Introduction, Notes and Diagrams, by J. F. Halls Dally, M.A., M.D., etc. Dedicated to the Bishop of London. Crown 8vo, cloth, 6s. net.

RUDIMENTS OF VOCAL MUSIC. With 42 Preparatory Exercises, Rounds and Songs in the Treble Clef. By T. Mee Pattison. Second Edition. Crown 8vo, paper, 4d. *net.*

SIMPLICITY AND NATURALNESS IN VOICE PRODUCTION. A Plea and an Argument. By Edwin Wareham. Crown 8vo, cloth, 2s. 6d. net.

OBSERVATIONS ON THE FLORID SONG. Or Sentiments on the Ancient and Modern Singers. By P. F. Tosi. Translated by Mr. Galliard. With folding Musical Examples. 184 pages. A Reprint of this Celebrated Book, first published in 1743. Crown 8vo, boards, with vellum-like back. 21s. *net.*

Recommended to all students of the Italian method of singing by the late Charles Lunn.

"The aged teacher embodies his own experience and that of his contemporaries at a time when the art was probably more thoroughly taught than it has ever been since."—*Grove's Dictionary.*

ELEMENTARY LESSONS ON SIGHT SINGING. Combining the Staff and Tonic Sol-fa Notations. With Music Examples throughout. By J. W. Rossington, L.R.A.M. Cloth, 3s. 6d. *net* (paper, 2s. *net*).

For many singers there is only one method of becoming good sight-readers, viz., combining the tonic sol-fa with the staff notation.

THE ART OF VOCAL EXPRESSION. A Popular Handbook for Speakers, Singers, Teachers and Elocutionists. By the Rev. Chas. Gib. Crown 8vo, cloth, 5s. *net*; paper, 2s. 6d. *net.*

THE THROAT IN ITS RELATION TO SINGING. A Series of Popular Papers. By Whitfield Ward, A.M., M.D. Illustrations. Second Edition. Crown 8vo, cloth, 5s. *net*;

Contents: Anatomical Structure of the Throat; What we See with the Laryngoscope; How we Sing; How we Breathe; How to take Care of the Voice; Hints to Voice Builders; How the Voice is Destroyed; Common Throat Affections of Singers, together with their Treatment, etc.

HOW TO ATTAIN THE SINGING VOICE, or Singing Shorn of its Mysteries. A Popular Handbook for those desirous of winning Success as Singers. By A. Richards Broad. Crown 8vo, cloth, 6s. net.

This is the book which fitted Eva Turner to achieve for her wonderful successes in the operatic world (in Italy, Germany, Portugal, etc., as well as in her own country). It should help you to achieve great things too.

TWENTY LESSONS ON THE DEVELOPMENT OF THE VOICE. For Singers, Speakers and Teachers. By G. E. Thorp. Fourth Edition. Crown 8vo, limp cloth, 2s. 6d. *net*.

TREATISE ON THE TRAINING OF BOYS' VOICES. With Examples and Exercises and Chapters on Choir-Organization. Compiled for the Use of Choirmasters. By George T. Fleming. Second Edition. Crown 8vo, cloth, 5s. *net*; paper, 2s. 6d. *net*.

GRADUATED COURSE OF EXERCISES FOR BOY CHORISTERS. With Piano Accompaniment. For Use in Conjunction with Above. By G. T. Fleming. 4to album, paper, 2s. *net*.

——— Ditto, Boy's Voice Part only, 1s. *net*.

SIX SPIRITUAL SONGS FOR UNACCOMPANIED CHORUS, with Piano Accomp. (for Practice). By Rutland Boughton. In one vol. Roy. 8vo, 2s. 6d. *net*.

VOCAL EXERCISES FOR CHOIRS AND SCHOOLS. By Dr. Westbrook. Post 8vo, paper, 2d. *net*.

THE CENTRAL POINT IN BEAUTIFUL VOICE PRODUCTION. By H. Travers Adams, M.A. Cloth, 2s. 6d. *net*

HOW TO MANAGE A CHORAL SOCIETY. By N. Kilburn, Mus.Bac. Third Edition Revised. Crown 8vo, paper, 1s.

A CHAT WITH CHORAL SINGERS. By H. W. Sparrow, A.R.C.O. 8vo, paper cover, 1s. *net*.

Contents: Reading Music—Tone Production—Breathing—Phrasing—Expression—Enunciation—Blend of Voices—Tone, Attack, Release—Care of the Voice—Suggestions.

HOW TO SING AN ENGLISH BALLAD. By E. Philp. Seventh Edition. Crown 8vo, paper, 1s. *net*.

THE MUSIC STORY SERIES.

"The Music Story" Series books are indispensable, authoritative, interesting and educational. Specially designed cloth, crown 8vo, well got up, at prices named below.

CHAMBER MUSIC AND ITS MASTERS IN THE PAST AND IN THE PRESENT. By Dr. N. Kilburn. New Edition, revised, and with additional chapters by G. E. H. Abraham. With Plates and Music Illustrations. Crown 8vo, cloth, 15s. *net*.

The opportunity of the issue of a new edition of the late Dr. Kilburn's book has been taken to bring it thoroughly up-to-date by necessary alterations and additional chapters. Notes have also been inserted on one or two older composers who have not previously been included. The principal additions are the concluding part of Chapter II, part of the survey of Beethoven's chamber music (the quartets in particular), the sections on Smetana, Grieg, Franck and Wolf, almost the whole of Chapter IX, and Chapters X and XI in entirety.

The book now gives us a discussion on the most important writers and projectors of chamber music, from the days of the Stuarts onwards through the period of Frederick the Great up to the present time.

MINSTRELSY. By Edmondstoune Duncan. The whole body of Secular Music that has stood the test of time and which can be called national. Early Gleemen, the Minstrels (church and social), Troubadours, the Tudor period, the great Elizabethanists, etc. Pp. xvi, 337, 16s. *net*.

MUSICAL FORM. By C. Lucas. The General Principles of the Art of Composition and how they have been arrived at; explaining the development of the scale, of tonic and dominant, cadences, phrases and motives, counterpoint, canon and fugue, harmony, style, song form, variations, sonata form. Pp. xvi, 226, 16s. *net*.

MISCELLANEOUS.

JOHN GAY'S "BEGGAR'S OPERA." Piano Selection arranged by H. R. Hood from the original Music by Dr. Pepusch. Performed at Drury Lane and Covent Garden. Folio, 1s. *net*.

Ditto, arranged for Violin and Piano. By H. R. Hood. 2s. *net*.

BLEST BE THAT AGE. Vocal Trio for Tenor, Baritone and Bass. Words from Masonic Ritual. Music with Piano Accompaniment. By H. Bond. Folio, 2s. *net*.

TRIO FOR PF., VN. AND 'CELLO.—Beethoven's Celebrated Minuet in G, No. 2, Score and Parts. Folio, 2s. *net*. Also arranged for Vn. and Pf., 2s. *net*, and Pf. Solo, 1s. 6d. *net*.

EASY TRIOS. Arranged from Classical Composers. By S. O. Goldsmith, for Piano, Violin and Violoncello. Score and Parts. Two books, each 3s. *net*.

Book I: 1. Minuet (Beethoven); 2. Moment Musical (Schubert); 3. Largo (Tartini); 4, Chiarina (Schumann); 5, Minuet (Pugnani). Book II: 6. Bourré (Martini); 7. Chanson Triste (Tchaïkovsky); 8. Scherzino (Schumann); 9. Song without Words, No. 3 (Mendelssohn).

THE CREATION. By Haydn. Performing Edition. Edited by G. A. Macfarren. Paper, 3s. *net*, boards, 4s. *net*.
The edition as conducted by Sir Henry Wood in 1926, etc.

TWO SETS OF UNACCOMPANIED CHORAL VARIATIONS UPON ENGLISH FOLK SONGS, by Rutland Boughton (with Piano Acomp. for practice only). 1s. 8d.

(a) The Barkshire Tragedy.
(b) King Arthur had Three Sons.

A Second Series by Rutland Boughton. 1s. 8d.

(a) William and Margaret.
(b) Widdecombe Fair.

King Arthur, separately from the First Set, 9d.

MODEST IDYLLS FOR MUSICAL SETTING. By Ernest Alfieri. Crown 8vo, sewed, 2s. 6d. *net.*

SONGS FROM THE RAVEL. (Words for Musical Setting.) A Book of Prose-Lyrics from Life and Nature. By Ernest Austin. Op. 30. Crown 8vo, sewed, 2s. 6d. *net.*

50 MUSICAL HINTS TO CLERGYMEN. Management of Breath, Classification of Male Voices, Management of the Voice, The Service. With Twenty specially written Exercises. By Geo. F. Grover. Cr. 8vo, paper, 1s. *net.*

NATIONAL NURSERY RHYMES. Arranged as a School Chorus for Boys and Girls. By N. B. Woodd Smith. With Pianoforte Accompaniment. 8vo, 1s. 6d. *net.*

TUTORS AND EXERCISE BOOKS.

THE POPULAR PIANO TUTOR, folio, 2s. 6d. *net*. (For description see Pianoforte Section of Catalogue.)

DEPPE FINGER EXERCISES. By Amy Fay. (See Pianoforte Section of this Catalogue.)

REEVES' VAMPING TUTOR. By Francis Taylor. (See Pianoforte Section of this Catalogue.)

CZERNY'S 101 EXERCISES for the Pianoforte. Complete, 4s. *net*; or in 2 books, 2s. *net* each.

GRADUATED SCALE AND ARPEGGIO MANUAL. By Henry Saint-George. (See Pianoforte Section of this Catalogue.)

ROYSTON'S PROGRESSIVE VIOLIN TUTOR (with Illustrations giving Correct Position for Hand, Wrist and Fingers.) Folio, 3s. *net*.

VIOLONCELLO EXERCISES, SCALES AND ARPEGGIOS. By E. Gillet. Complete in one vol., 4s. *net*; or Part I, Exercises, 1s. 6d. *net*, Part II, Scales, 1s. 6d. *net*, and Part III, Arpeggios, 1s. 6d. *net*.

ART OF VIOLONCELLO PLAYING, TUTOR. By E. van der Straeten. Text in French and English. Part I, 3s. 6d. *net*. Part II, 4s. *net*.

YOUNG VIOLINIST'S SCALE AND ARPEGGIO MANUAL, with Directions. By Wilson Manhire. Text and Music. Folio, 2s. *net*.

70 PREPARATORY VIOLIN EXERCISES for Beginners in the First Position. Carefully Graduated. Supplementary to the First Instruction Book. By Wilson Manhire. 2s. 6d. *net*.

SCALES AND ARPEGGIOS. Indispensable Studies for the Violin. Edited by Albert Graff. 1s. 6d. *net*.

ARPEGGIOS FOR THE VIOLIN. By Basil Althaus. Folio, 3s. *net*.

ADVANCED MODERN VIOLIN TECHNICS.

TONAL SCALES AND ARPEGGIOS FOR VIOLIN. Introductory to the Unusual Intonation and Finger-grouping of Advanced Modern Music. By SYDNEY TWINN. 4to, 3s. *net*.

THE VIOLIN AND BOW. A Treatise (in English, French and German), with numerous Photographic Illustrations, supplemented by various Examples and Original Studies, by I. B. POZNANSKI. 5s. *net*.

Printed in Great Britain by Lowe & Brydone (Printers) Ltd., London, N.W.10.